Montana Department of
ENVIRONMENTAL QUALITY

CIRCULAR DEQ 2

DESIGN STANDARDS
FOR
WASTEWATER FACILITIES

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1999 EDITION

CIRCULAR DEQ 2
(formerly Circular WQB 2)

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Montana Department of Environmental Quality
(Established 07/01/95; formerly Montana Department of Health
and Environmental Sciences)

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FOREWORD

The Board of Environmental Review of the State of Montana, as authorized by 75-6-103(2)(f), MCA, has adopted the following standards for wastewater works. The terms "department","reviewing authority" and "reviewing agency" as used in these standards refer to the Montana Department of Environmental Quality (DEQ) or its authorized agents.

These standards are intended for wastewater facilities insofar as the criteria are applicable to normal situations for an individual project. The design criteria in these standards are intended for the more conventional municipal wastewater collection and treatment systems. Innovative approaches to collection and treatment, particularly for the very small municipal systems, are not included. The DEQ should be contacted for design guidance and criteria where such systems are being considered.

Lack of description or criteria for a unit process does not suggest it should not be used, but only that consideration by the appropriate reviewing agency will be on the basis of information submitted with the design. Engineering data that may be required by the reviewing agency, for new process and application evaluation is included in Section 53.2 of these standards.

These standards are intended to define limiting values for items upon which an evaluation of such plans and specifications will be made by the reviewing authority; and to establish, as far as practicable, uniformity of practice. Users should also be cognizant of applicable federal requirements.

Deviations from the criteria are allowed on a case-by-case basis. The design engineer must submit a request, with appropriate technical justification, for a deviation from a specific section of the standards indicating how the criteria will be changed.

The terms "shall", "must" and "required" are used where practice is sufficiently standardized to permit specific delineation of requirements or where safeguarding of the public health or protection of water quality justifies such definite action. Other terms, such as "should," "may," "recommended," and "preferred," indicate desirable procedures or methods

Definition of terms and their use in these standards is intended to be in accordance with GLOSSARY-WATER AND WASTEWATER CONTROL ENGINEERING, jointly prepared by APHA, ASCE, AWWA and WPCF. The units of expression used are in accordance with those recommended in WPCF MANUAL OF PRACTICE NUMBER 6, UNITS OF EXPRESSION FOR WASTEWATER TREATMENT.

These standards are based on Circular WQB-2, Montana Department of Environmental Quality, Design Standards for Wastewater Facilities, 1995 Edition, that were based on "The Recommended Standards for Wastewater Facilities", 1990 Edition, prepared by the Great Lakes Upper Mississippi River Board of State Sanitary Engineers. Some modifications were prompted by the "Recommended Standards for Wastewater Facilities", 1997 Edition, prepared by the Great lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. The Board of Environmental Review expresses its appreciation to the Great Lakes Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers for its contribution to public health.

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CHAPTER 10
ENGINEERING REPORTS AND FACILITY PLANS

10. GENERAL

10.1 Project Submittals

The engineering report or facilities plan, including project design criteria, must be submitted prior to submission of project plans and specifications. Final plans and specifications must be submitted at least 60 days prior to the date on which action by the reviewing authority is desired. Two copies of the final plans must be submitted. Upon approval, one set of the approved plans and specifications must be stamped "approved", dated, signed by a DEQ representative and returned to the applicant.

No approval for construction can be issued until final, detailed plans and specifications have been submitted and approved by the reviewing agency. Within 90 days following completion of project construction, a professional engineer registered in Montana must certify that the project was built in accordance with the approved plans and specifications.

A set of "as built" drawings must accompany the certification.

11. ENGINEERING REPORT OR FACILITY PLAN

For federal or state financed grant or loan projects, additional requirements may apply.

The Engineering Report or Facility Plan: identifies and evaluates wastewater related problems; assembles basic information; presents criteria and assumptions; examines alternate projects with preliminary layouts and cost estimates; describes financing methods, sets forth anticipated charges for users; reviews organizational and staffing requirements; offers a conclusion with a proposed project for client consideration and outlines official actions and procedures to implement the project. The planning document must include sufficient detail to demonstrate that the proposed project meets applicable criteria.

The concept (including process description and sizing), factual data and controlling assumptions and considerations for the functional planning of wastewater facilities are presented for each process unit and for the whole system. These data form the continuing technical basis for the detailed design and preparation of construction plans and specifications. Architectural, structural, mechanical, and electrical designs are usually excluded. Sketches may be desirable to aid in presentation of a project. Outline specifications of process units, special equipment, etc., are occasionally included.

Engineering Reports must be completed for minor collection system, pump station, and interceptor projects. Comprehensive Facility Plans must be completed or have been completed for projects involving new, expanded, upgraded, or rehabilitated wastewater treatment facilities and major collection, interceptor sewer, and pump station projects. The determination of classification as major or minor collection interceptor sewer and pump station projects will be made by the regulatory agency.

11.1 Engineering Reports

Engineering reports for minor sewer extensions, lift stations, and interceptors must contain the following and other pertinent information as required by the reviewing agency.

11.11 Problem Defined

Description of the existing system should include an evaluation of the conditions and problems needing correction.

11.12 Design Conditions

The anticipated average and peak flows for existing and ultimate conditions must be established. The basis of the projection of initial and future flows and waste loads must be included and must reflect the existing or initial service area and the anticipated future service area.

11.13 Impact on Existing Wastewater Facilities

The impact of the proposed project on all existing wastewater facilities, including gravity sewers, lift stations, and treatment facilities must be evaluated.

11.14 Project Description

A written description of the project is required and site drawings attached where necessary for clarity.

11.15 Design Criteria

Engineering design criteria to be used in design of the project must be included.

11.16 Site Information

Project site information should include topography, soils, geologic conditions, depth to bedrock, groundwater level, floodway or floodplain considerations, and other pertinent site information.

11.17 Environmental Impacts

Adverse environmental impacts resulting from the project should be addressed including mitigation efforts.

11.2 Facility Plans

Facility Plans must be completed for wastewater treatment facilities, major collection systems, and those interceptor sewers, and pump stations serving major areas. Facility Plans must contain the following and other pertinent information as required by the reviewing agency.

11.21 Problem Evaluation and Existing Facility Review

a. Descriptions of existing system including condition and evaluation of problems needing correction.

b. Summary of existing and previous local and regional wastewater facility and related planning documents.

11.22 Planning and Service Area

Planning area and existing and potential future service area should be described on a drawing.

11.23 Population Projection and Planning Period

Present and predicted population must be based on a 20 year planning period. Phased construction of wastewater facilities should be considered in rapid growth areas.

11.24 Hydraulic Capacity

11.241 Flow Definitions and Identification

The following flows for the design year must be identified and used as a basis for design for sewers, lift stations, wastewater treatment plants, treatment units, and other wastewater handling facilities. Where any of the terms defined in this section are used in these design standards, the definition contained in this section applies.

a. Design Average Flow

The design average flow is the average of the daily volumes to be received for a continuous 12-month period expressed as a volume per unit time. However, the design average flow for facilities having critical seasonal high hydraulic loading periods must be based on the daily average flow during the seasonal period.

b. Design Maximum Day Flow

The design maximum day flow is the largest volume of flow to be received during a continuous 24-hour period expressed as a volume per unit time.

c. Design Peak Hourly Flow

The design peak hourly flow is the largest volume of flow to be received during a one-hour period expressed as a volume per unit time.

d. Design Peak Instantaneous Flow

The design peak instantaneous flow is the instantaneous maximum flow rate to be received.

11.242 Hydraulic Capacity for Wastewater Facilities to Serve Existing Collection Systems

Projections must be made from actual flow data to the greatest extent possible, including the influence of infiltration and inflow. Seasonal variations in flow must be considered.

11.243 Hydraulic Capacity for Wastewater Facilities to Serve Ne w Collection Systems

a. The sizing of wastewater facilities receiving flows from new wastewater collection systems must be based on an average daily flow of 100 gallons (0.38 m^3) per capita plus wastewater flow from industrial plants and major institutional and commercial facilities unless water use data or other justification upon which to better estimate flow is provided.

b. The 100 gpcd figure must be used which, in conjunction with a peaking factor from Figure 1, is intended to cover normal infiltration for systems built with modern construction techniques.

c. If the new collection system is to serve existing development the likelihood of I/I contributions from existing service lines must be evaluated and wastewater facilities designed accordingly.

11.244 Combined Sewer Interceptors

In addition to the above requirements, interceptors for combined sewers must have capacity to receive sufficient quantity of combined wastewater for transport to treatment works to insure attainment of the appropriate state and federal water quality standards.

11.25 Organic Capacity

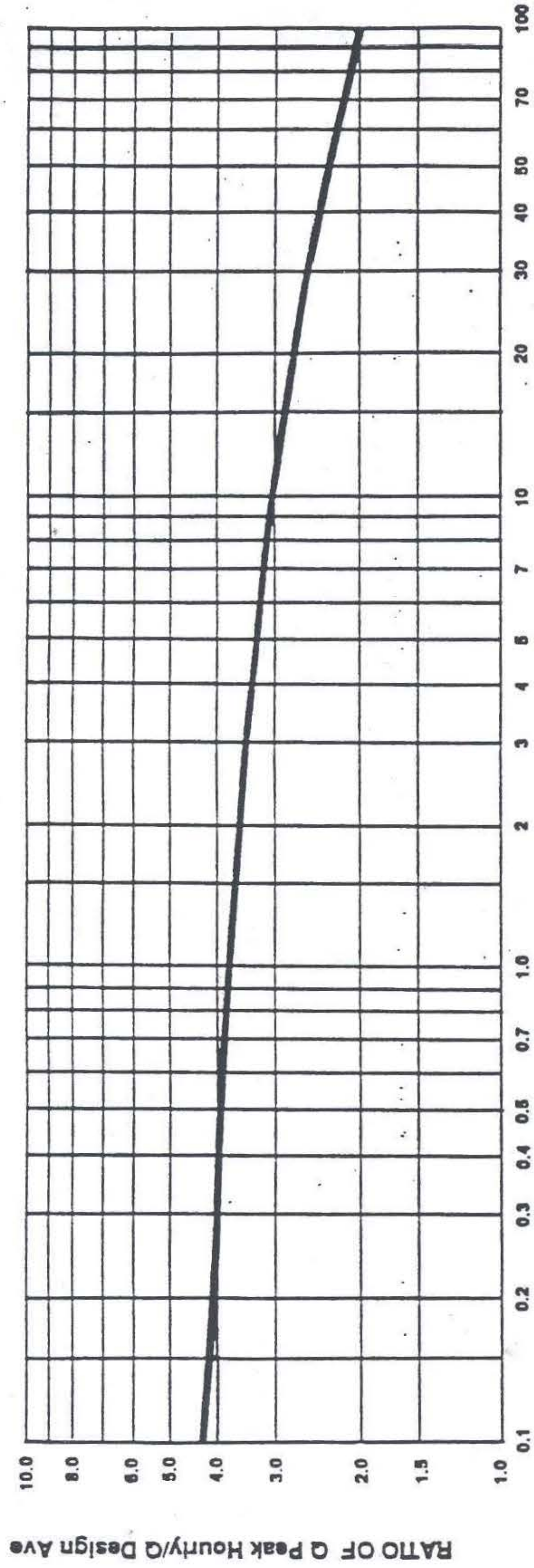
11.251 Organic Load Definitions and Identification

The following organic loads for the design year must be identified and used as a basis for design of wastewater treatment facilities.

a. Biochemical Oxygen Demand Defined

The 5-day Biochemical Oxygen Demand (BOD_5) is defined as the amount of oxygen required to stabilize biodegradable organic matter under aerobic conditions within a five day period in accordance with "Standard Methods", latest edition. Total 5-day Biochemical Oxygen Demand ($TBOD_5$) is equivalent to BOD_5 and is sometimes used in order to differentiate carbonaceous plus nitrogenous oxygen demand from strictly carbonaceous oxygen demand.

FIGURE 1
Ratio of Peak Hourly Flow to Design Average Flow



POPULATION IN THOUSANDS

Q peak hourly: Maximum Rate of Wastewater Flow (Peak Hourly Flow)

Q design ave: Design Average Daily Wastewater Flow

Source: Q Peak Hourly/Q Design Ave $= \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$ - - - (P = population in thousands)

Fair, G.M. and Geyer, J.C. "Water Supply and Waste-water Disposal"
1st Ed., John Wiley & Sons, Inc., New York (1954), p. 136

The carbonaceous 5-day Biochemical Oxygen Demand ($CBOD_5$) is defined as BOD_5 less the nitrogenous oxygen demand of the wastewater. See "Standard Methods", latest edition.

b. Design Average BOD_5

The design average BOD_5 is generally the average of the organic load received for a continuous 12-month period for the design year expressed as weight per day. However, the design average BOD_5 for facilities having critical seasonal high loading periods must be based on the daily average BOD_5 during the seasonal period.

c. Design Maximum Day BOD_5

The design maximum day BOD_5 is the largest amount of organic load to be received during a continuous 24-hour period expressed as weight per day.

d. Design Peak Hourly BOD_5

The design peak hourly BOD_5 is the largest amount of organic load to be received during a one-hour period expressed as weight per day.

11.252 Design of Organic Capacity of Wastewater Treatment Facilities to Serve Existing Collection Systems.

a. Projections must be made from actual wasteload data to the extent possible.

b. Projections must be compared to Section 11.253 and an accounting made for significant variations from those values.

c. Impact of industrial sources must be documented. For projects with significant industrial contributions, evidence of adequate pretreatment strategies must be included.

d. The discharge of septage must be considered in evaluating the organic loading to the proposed treatment facility. See Appendix A, Handling and Treatment of Septage at a Wastewater Treatment Plant.

11.253 Organic Capacity of Wastewater Treatment Facilities to Serve New Collection Systems.

a. Domestic waste treatment design must be on the basis of at least 0.20 pounds (0.09 kg) of BOD_5 per capita per day and 0.22 pounds (0.10 kg) of suspended solids per capita per day, unless information is submitted to justify alternate designs.

b. Industrial contributions. Refer to Section 11.252(c).

c. Septage and Leachate. Refer to Section 11.252(d).

11.26 Wastewater Treatment Facility Design Capacity

The wastewater treatment facility design capacity is the design average flow at the design average BOD_5. Refer to Sections 11.24 and 11.25 for peaking factors that will be required.

11.27 State and Federal Treatment Standards

The facilities plan should identify current and anticipated effluent requirements and describe how the proposed facility will comply with the standards. The effect of the State's Non-Degradation Policy should also be addressed.

11.28 Initial Alternative Developme nt

The process of selection of wastewater treatment alternatives for detailed evaluation must be discussed in the facility plan. All wastewater management alternatives considered, including no action, and the basis for the engineering judgement for selection of the alternatives chosen for detailed evaluation, must be included.

11.29 Detailed Alternative Evaluation

The following must be included for the alternatives to be evaluated in detail.

a. Sewer System Revisions

Proposed revisions to the existing sewer system including adequacy of portions not being changed by the project.

b. Site Evaluation

When a site must be used which is critical with respect to these items, appropriate measures must be taken to minimize adverse impacts.

1. Compatibility of the treatment process with the present

and planned future land use, including noise, potential odors, air quality, and anticipated sludge processing and disposal techniques, must be considered.

2. Zoning and other land use restrictions must be identified.

3. An evaluation of the accessibility and topography of the site must be submitted.

4. Area for future plant expansion must be identified.

5. Direction of prevailing wind must be identified. Other climatological data should be provided.

6. Flood considerations, including the 25 and 100 year flood levels, impact on floodplain and floodway, and compliance with applicable regulations regarding construction in flood prone areas, must be evaluated. Section 51.2 contains requirements for protection from flooding.

7. Geologic information, depth to bedrock, karst features, or other geologic considerations of significance to the project must be included.

8. Protection of groundwater including public and private wells is of utmost importance. Demonstration that protection will be provided must be included. The regulatory agency must be contacted for required separation.

9. Soil type and suitability for construction and depth to normal and seasonal high groundwater must be identified.

10. The location, depth, and discharge point of any field tile in the immediate area of the proposed site must be identified.

11. A preliminary assessment of site availability must be included.

c. Unit Sizing

Unit operation and unit process sizing and basis must be provided.

d. Flow Diagram

Flow diagram of treatment facilities including all recycle flows.

e. Emergency Operation

Emergency operation requirements as outlined in Section 46 and Section 56.1 must be provided.

f. Technology Not Included in These Standards

Section 53.2 outlines procedures for introducing and obtaining approval to use technology not included in these standards. Proposals to use technology not included in these standards must address the requirements of Section 53.2

g. Sludge

The solids disposal options considered and method selected must be included. This is critical to completion of a successful project. Compliance with requirements of Chapter 80, Sludge Processing, Storage, and Disposal must be assured.

h. Treatment During Construction

A plan for the method and level of treatment to be achieved during construction must be developed and included in the facility plan that must be submitted to the reviewing agency for review and approval. The approved treatment plan must be implemented by inclusion in the plans and specifications to be bid for the project. Refer to Section 20.15 and Section 21.

i. Operation and Maintenance

Portions of the project which involve complex operation or maintenance requirements must be identified including laboratory requirements for operation, industrial sampling, and self-monitoring. An operation and maintenance manual will be required unless waived by the reviewing agency.

j. Cost Estimates

Cost estimates for capital and operation and maintenance (including basis) and an economic analysis of these costs must be included.

k. Environmental Review

The environmental effects of each alternative should be evaluated. Consideration must be given to minimizing any potential adverse environmental effects of the proposed project. Environmental information provided on the proposed project will be used by the DEQ in complying with review procedures required under the Montana Environmental Policy Act and related administrative rules.

11.30 Final Project Selection

The project selected from the alternatives considered under Section 11.28 must be set forth in the final facility plan document to be forwarded to the regulatory agency for review and approval, including the financing considerations and recommendations for implementation of the plan. Evidence that the owner agrees (e.g., council resolution) with the recommendations of the plan should be provided.

CHAPTER 20
ENGINEERING PLANS AND SPECIFICATIONS

20. PLANS AND SUPPORT DOCUMENTS

Submissions to the reviewing agency must include sealed plans, design criteria, the appropriate construction permit applications, review forms, information required in Appendix E and permit fee if required.

20.1 GENERAL

20.11 Plan Title

All plans for wastewater facilities must bear a suitable title showing the name of the municipality, sewer district, or institution. They must show the scale in feet or metric measure, a graphical scale, the north point, date, and the name of the engineer, with his or her certificate number and imprint of the registration seal. A space should be provided for signature and/or approval stamp of the appropriate reviewing agencies.

20.12 Plan Format

The plans must be clear and legible (suitable for microfilming). They must be drawn to a scale which will permit all necessary information to be plainly shown. Generally, the size of the plans should not be larger than 30 inches x 42 inches (762 mm x 1070 mm). Datum used should be indicated. Locations and logs of test borings, when required, must be shown on the plans.

20.13 Plan Contents

Detail plans must consist of: plan views, elevations, sections, and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the facilities. They must also include: dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels, and ground elevations.

20.14 Design Criteria

Design criteria must be included on all plans and specifications and a hydraulic profile must be included for all wastewater treatment facilities.

20.15 Operation During Construction

Project construction documents must specify the procedure for operation during construction that complies with the plan required by Section 11.29(h), Treatment During Construction.

20.2 Plans of Sewers

20.21 General Plan

A comprehensive plan of existing and proposed sewers must be submitted for projects involving new sewer systems and substantial additions to existing systems. This plan must show the following:

20.211 Geographical Features

a. Topography and elevations - Existing or proposed streets and all streams or water surfaces must be clearly shown. Contour lines at suitable intervals should be included.

b. Streams - The direction of flow in all streams, and high and low water elevations of all water surfaces at sewer outlets and overflows must be shown.

c. Boundaries - The boundary lines of the municipality or the sewer district, and the area to be sewered, must be shown.

20.212 Sewers

The plan must show the location, size, and direction of flow of all existing and proposed sanitary and combined sewers draining to the treatment facility concerned.

20.22 Detail Plans

Detail plans must be submitted. Profiles should have a horizontal scale of not more than 100 feet to the inch (1200:1) and a vertical scale of not more than 10 feet to the inch (120:1). Plan views should be drawn to a corresponding horizontal scale and must be shown on the same sheet. Plans and profiles must show:

a. Location of streets and sewers;

b. Line of ground surface; size, material, and type of pipe; length between manholes; invert and surface elevation at each manhole; and grade of sewer between each two adjacent manholes (All manholes must be numbered on the profile);

Where there is any question of the sewer being sufficiently deep to serve any residence, the elevation and location of the basement floor must be plotted on the profile of the sewer which is to serve the house in question. The engineer shall state that all sewers are sufficiently deep to serve adjacent basements except where otherwise noted on the plans;

c. Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, etc.;

d. All known existing structures and utilities, both above and below ground, which might interfere with the proposed construction or require isolation setback, particularly water mains and water supply structures (i.e., wells, clear wells, basins), gas mains, storm drains, and telephone and power conduits; and

e. Special detail drawings, made to a scale to clearly show the nature of the design, must be furnished to show the following particulars:

All stream crossings and sewer outlets, with elevations of the stream bed and normal and extreme high and low water levels;

Details of all special sewer joints and cross sections; and

Details of all sewer appurtenances such as manholes, lampholes, inspection chambers, inverted siphons, regulators, tide gates, and elevated sewers.

20.3 Plans of Sewage Pumping Stations

20.31 Location Plan

A plan must be submitted for projects involving construction or revision of pumping stations. This plan must show the following:

a. The location and extent of the tributary area;

b. Any municipal boundaries within the tributary area; and

c. The location of the pumping station and force main, and pertinent elevations.

20.32 Detail Plans

Detail plans must be submitted showing the following, where applicable:

a. Topography of the site;

b. Existing pumping station;

c. Proposed pumping station, including provisions for installation of future pumps or ejectors;

d. Elevation of high water at the site, and maximum elevation of wastewater in the collection system upon occasion of power failure;

e. Maximum hydraulic gradient in force main (including surge) and downstream gravity sewers when all installed pumps are in operation; and

f. Test borings and groundwater elevations.

20.4 Plans of Wastewater Treatment Plants

20.41 Location Plan

A plan must be submitted showing the wastewater treatment plant in relation to the remainder of the system.

Sufficient topographic features must be included to indicate the plant's location with relation to streams and the point of discharge of treated effluent.

20.42 General Layout

Layouts of the proposed wastewater treatment plant must be submitted, showing:

a. Topography of the site;

b. Size and location of plant structures;

c. Schematic flow diagram(s) showing the flow through various plant units, and showing utility systems serving the plant processes;

d. Piping, including any arrangements for bypassing individual units (materials handled and direction of flow through pipes must be shown);

e. Hydraulic profiles showing the flow of wastewater, supernatant liquor, and sludge; and

f. Test borings and groundwater elevations.

20.43 Detail Plans

Detail plans must show the following:

a. Location, dimensions, and elevations of all existing and proposed plant facilities;

b. Elevations of high and low water level of the body of water to which the plant effluent is to be discharged;

c. Type, size, pertinent features and operating capacity of all pumps, blowers, motors and other mechanical devices;

d. Minimum, design average, and peak hourly hydraulic flow in profile; and

e. Adequate description of any features not otherwise covered by specifications or engineer's report.

21. SPECIFICATIONS

Complete detailed technical specifications must be submitted for the proposed project, and must accompany the plans.

The specifications accompanying construction drawings must include, but not be limited to, specifications for the approved procedures for operation during construction in accordance with Sections 11.28(h) and 20.15, all construction information not shown on the drawings which is necessary to inform the builder in detail of the design requirements for the quality of materials, workmanship, and fabrication of the project.

The specifications must also include: the type, size, strength, operating characteristics, and rating of equipment; allowable infiltration; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping and jointing of pipe; electrical apparatus, wiring, instrumentation, and meters; laboratory fixtures and equipment; operating tools, construction materials; special filter materials, such as, stone, sand, gravel, or slag; miscellaneous appurtenances; chemicals when used; instructions for testing materials and equipment as necessary to meet design standards; and performance tests for the completed works and component units. It is suggested that these performance tests be conducted at design load conditions wherever practical.

21.1 O&M Manual

An Operation and Maintenance Manual is required for wastewater treatment facilities and sewage lift stations.

22. REVISIONS TO APPROVED PLANS

Any changes to the approved plans or specifications affecting capacity, flow, operation of units, or point of discharge must be approved, in writing, before such changes are made. Plans or specifications so revised should, therefore, be submitted well in advance of any construction work which will be affected by such changes to permit sufficient time for review and approval. Structural revisions or other minor changes not affecting capacities, flows, or operation will be permitted during construction without approval.

"As built" plans clearly showing such alterations must be submitted to the reviewing agency at the completion of the work.

23. ADDITIONAL INFORMATION REQUIRED

The reviewing authority may require additional information which is not part of the construction drawings, such as head loss calculations, proprietary technical data, copies of deeds, copies of contracts, etc.

24. DEVIATIONS FROM STANDARDS

Deviations from the mandatory requirements of these standards may be granted by the DEQ Deviation Review Committee. Deviations are granted on a case-by-case basis and are applicable only to specific projects.

24.1 Procedure

24.11 A person desiring a deviation shall make a request in writing. The request must identify the specific section of the standards to be considered. Adequate justification for the deviation must be provided. "Engineering judgement" or "professional opinion" without supporting data is not considered adequate justification.

24.12 A panel of three persons from the DEQ shall review the request and reach a decision by majority vote. The panel will make final determinations on limited deviations.

24.13 A file of all deviations must be maintained by the DEQ.

CHAPTER 30
DESIGN OF SEWERS

31. SEPARATION OF CLEAR WATER

Sewers must be designed for municipal wastewater only. Rain water from roofs, streets, and other areas, and groundwater from foundation drains must not be permitted in municipal wastewater sewers.

32. DESIGN CAPACITY AND DESIGN FLOW

In general, sewer capacities should be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions, industrial parks, etc. Where future relief sewers are planned, economic analysis of alternatives should accompany initial permit applications. See Sections 11.24 and 20.2.

33. DETAILS OF DESIGN AND CONSTRUCTION

33.1 Minimum Size

A gravity sewer conveying raw wastewater must be at least 8 inches (203 mm) in diameter. Gravity sewer mains within private property; i.e., trailer courts, condominiums, apartments, etc., may be less than 8 inches in diameter, provided that a small diameter line can be shown to be hydraulically feasible, that no future expansion is anticipated, and that maintenance would not be increased. Generally, sewer size would be restricted to a minimum of 6 inches in diameter.

33.2 Depth

In general, sewers should be sufficiently deep to receive wastewater from basements and to prevent freezing. Insulation must be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

33.3 Buoyancy

Buoyancy of sewers must be considered and flotation of the pipe must be prevented with appropriate construction where high groundwater conditions are anticipated.

33.4 Slope

33.41 Recommended Minimum Slopes

All sewers must be designed and constructed to provide the pipe-full velocities and the minimum slopes listed in the following table. These values are based on Manning's formula using an "n" value of 0.013. The following are the minimum slopes that must be provided; however, slopes greater than these are desirable.

Minimum Slope in Feet	
Sewer Size	Per 100 Feet (m/100m)
6 inch (152 mm)	0.60
8 inch (203 mm)	0.40
10 inch (254 mm)	0.28
12 inch (305 mm)	0.22
14 inch (356 mm)	0.17
15 inch (381 mm)	0.15
16 inch (406 mm)	0.14
18 inch (457 mm)	0.12
21 inch (533 mm)	0.10
24 inch (610 mm)	0.08
27 inch (686 mm)	0.067
30 inch (762 mm)	0.058
33 inch (838 mm)	0.052
36 inch (914 mm)	0.046
39 inch (991 mm)	0.041
42 inch (1067 mm)	0.037

33.42 Minimum Flow Depths

Slopes slightly less than those required may be permitted, only under extenuating circumstances. Such decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or greater for design average flow. The operating authority of the sewer system will give written assurance to the appropriate reviewing agency that any additional sewer maintenance required by reduced slopes will be provided.

33.43 Minimize Solids Deposition

The pipe diameter and slope must be selected to obtain the greatest practical velocities to minimize settling problems. Oversize sewers will not be approved to justify using flatter slopes. If the proposed slope is less than the minimum slope of the smallest pipe which can accommodate the design peak hourly flow, the actual depths and velocities at minimum, average, and design maximum day and peak hourly flow for each design section of the sewer must be calculated by the design engineer and be included with the plans.

33.44 Slope Between Manholes

Sewers must be laid with uniform slope between manholes.

33.45 High Velocity Protection

Where velocities greater than 15 feet per second (4.6 m/s) are attained, special provision must be made to protect against displacement by erosion and impact.

33.46 Steep Slope Protection

Sewers on 20 percent slopes or greater must be anchored securely with concrete, or equal, anchors spaced as follows:

a. Not over 36 feet (11 m) center to center on grades 20 percent and up to 35 percent;

b. Not over 24 feet (7.3 m) center to center on grades 35 percent and up to 50 percent; and

c. Not over 16 feet (4.9 m) center to center on grades 50 percent and over.

33.5 Alignment

Sewers 24 inches (610 mm) or less in diameter must be laid with straight alignment between manholes. Straight alignment must be checked by either using a laser beam or lamping.

Curvilinear alignment of sewers larger than 24 inches (610 mm) may be considered on a case-by-case basis providing compression joints are specified and ASTM or specific pipe manufacturers' maximum allowable pipe joint deflection limits are not exceeded. Curvilinear sewers must be limited to simple curves which start and end at manholes.

33.6 Changes in Pipe Size

When a smaller sewer joins a large one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

Sewer extensions should be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension. Special consideration should be given to minimizing turbulence when designing a flow channel within a manhole where there is a change in pipe size. The appropriate reviewing agency may require a schedule for construction of future downstream sewer relief.

33.7 Materials

Any generally accepted material for sewers will be given consideration, but the material selected should be adapted to local conditions, such as: character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion, corrosion, and similar problems.

Suitable couplings complying with ASTM specifications must be used for joining dissimilar materials. The leakage limitations on these joints must be in accordance with Sections 33.93 or 33.94.

All sewers must be designed to prevent damage from superimposed live, dead, and frost induced loads. Proper allowance must be made for loads on the sewer because of soil and potential groundwater conditions, as well as the width and depth of the trench. Where necessary, special bedding, haunching and initial backfill, concrete cradle, or other special construction must be used to withstand anticipated potential superimposed loading or loss of trench wall stability. See ASTM D 2321 or ASTM C 12 when appropriate. For new pipe materials for which ASTM standards have not been established, the design engineer shall provide complete pipe specifications and installation specifications developed on the basis of criteria adequately documented and certified in writing by the pipe manufacturer to be satisfactory for the specific detailed plans.

33.8 Installation

33.81 Standards

Installation specifications must contain appropriate requirements based on the criteria, standards, and requirements established by industry in technical publications. Requirements must be set forth in the project specifications for the pipe and methods of bedding and backfilling the pipe so as not to damage the pipe or its joints, impede cleaning operations and future tapping, or create excessive side fill pressures and ovalation of the pipe, or seriously impair flow capacity.

33.82 Trenching

a. The width of the trench must be ample to allow the pipe to be laid and jointed properly and to allow the bedding and haunching to be placed and compacted to adequately support the pipe. The trench sides must be kept as nearly vertical as possible. When wider trenches are specified, appropriate bedding class and pipe strength must be used.

All trenches must be constructed according to current O.S.H.A. standards. In unsupported, unstable soil, the size and stiffness of the pipe, stiffness of the embedment and insitu soil and depth of cover must be considered in determining the minimum trench width necessary to adequately support the pipe.

b. Ledge rock, boulders and large stones must be removed to provide a minimum clearance of 4 inches (102 mm) below and on each side of all pipe(s).

33.83 Bedding, Haunching, and Initial Backfill

a. Bedding classes A, B, C, or crushed stone as described in ASTM C 12 must be used and carefully compacted for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load, based on the type soil encountered and potential groundwater conditions.

b. Embedment materials for bedding, haunching and initial backfill Classes I, II or III, as described in ASTM D 2321, must be used Backfill, must be carefully compacted for all flexible pipe and the proper strength pipe, must be used with the specified bedding to support the anticipated load based on the type of soil encountered, and potential groundwater conditions.

c. All water entering the excavations or other parts of the work must be removed until all the work has been completed. No sanitary sewer may be used for the disposal of trench water, unless specifically approved by the engineer, and then only if the trench water does not ultimately arrive at existing pumping or wastewater treatment facilities. A construction Dewatering Discharge Permit, issued by DEQ, is required if water from construction is discharged to state waters. The DEQ must be contacted immediately if either contaminated soil or contaminated groundwater is encountered. If contamination is anticipated, an acceptable plan for handling and disposal must be submitted to DEQ for approval.

33.84 Final Backfill

a. Final backfill must be of a suitable material removed from the excavation except where other material is specified. Debris, frozen material, clods or stones larger than 8 inches, organic matter, or other unstable materials may not be used for final backfill within 1 foot of the top of the pipe.

b. Final backfill must be placed in such a manner as not to disturb the alignment of the pipe.

33.85 Deflection Test

a. The Engineer has the option of requiring deflection testing of a portion of, or all of, flexible pipe installations to assure the quality of construction. Flexible pipe is considered a conduit that will deflect at least 2 percent without any sign of structural distress.

Deflection tests, when performed on PVC pipe, must be conducted in accordance with ASTM D3034 and must satisfy either of the following deflection limitations:

Minimum Period Between Trench Backfilling & Testing	Minimum Mandrel Diameter as a Percent of Inside Pipe Diameter
7 days	95.0
30 days	92.5

b. If deflection exceeds the specified limits, replacement or correction must be accomplished in accordance with requirements in the approved specifications.

c. The rigid ball or mandrel used for the deflection test must have a diameter of at least 95 percent or 92.5 percent (depending on the time of test) of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM Specification, including the appendix, to which the pipe is manufactured. The pipe must be measured in compliance with ASTM D 2122 Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings. Mandrels must have at least nine arms. The test must be performed without mechanical pulling devices.

d. Deflection testing requirements for flexible pipe other than PVC, must be determined by the design engineer.

33.9 Joints and Infiltration

33.91 Joints

The installation of joints and the materials used must be included in the specifications. Sewer joints must be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

33.92 Leakage Tests

Leakage tests must be specified. This may include appropriate water or low pressure air testing. The testing methods selected should take into consideration the range in groundwater elevations during the test and anticipated during the design life of the sewer.

33.93 Water (Hydrostatic) Test

The leakage exfiltration or infiltration may not exceed 200 gallons per inch of pipe diameter per mile per day (0.019 m^3/mm of pipe dia/km/day) for any section of the system. An exfiltration or infiltration test must be performed with a minimum positive head of 2 feet (610 mm).

33.94 Air Test

The air test must, at a minimum, conform to the test procedure described in ASTM C-828-86 for clay pipe, ASTM C 924 for concrete pipe, UNI-B-6-90 low pressure test for PVC pipe. For other materials, test procedures must be approved by DEQ.

33.95 Service Connections

Service connections to the sewer main must be water tight and may not protrude into the sewer. If a saddle type connection is used, it must be a device intended to join with the types of pipe that are to be connected. All materials used to make service connections must be compatible with each other and with the pipe materials to be joined. All materials must be corrosion proof.

34. MANHOLES

34.1 Location

Manholes must be installed: at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet (122 m) for sewers 15 inches (381 mm) or less in diameter and 500 feet (152 m) for sewers 18 inches (457 mm) to 30 inches (762 mm), except that distances up to 600 feet (183 m) may be approved where adequate modern cleaning equipment for the spacing is provided. Greater spacing may be permitted in larger sewers. Cleanouts may be used only for special conditions and may not be substituted for manholes or installed at the end of laterals greater than 150 feet (46 m) in length.

34.2 Drop Type

A drop pipe should be provided for a sewer entering a manhole at an elevation of 24 inches (610 mm) or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches (610 mm), the invert should be filleted to prevent solids deposition.

Drop manholes should be constructed with an outside drop connection. Inside drop connections (when necessary) must be secured to the interior wall of the manhole and provide access for cleaning.

Due to the unequal earth pressures that would result from the backfilling operation in the vicinity of the manhole, the entire outside drop connection must be encased in concrete.

34.3 Diameter

The minimum diameter for manholes is 48 inches (1.22 m); larger diameters are preferable for large diameter sewers. A minimum access diameter of 22 inches (559 mm) must be provided.

34.4 Flow Channel

The flow channel straight through a manhole should be made to conform as closely as possible in shape and slope to that of the connecting sewers. For pipes greater than 8 inches in diameter, the channel walls should be formed or shaped to the full height of the crown of the outlet sewer in such a manner to not obstruct maintenance, inspection or flow in the sewers. For pipes 8 inches or less in diameter, the channel must be formed at least to the spring line of the pipe. When curved flow channels are specified in manholes, including branch inlets, or when entrance or exit losses are significant, minimum slopes indicated in Section 33.41, must be increased to maintain acceptable velocities.

34.5 Bench

A bench must be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench should be sloped no less than 1/2 inch (13 mm) per foot (305 mm) (4 percent). A lateral sewer, service connection, or drop manhole pipe may not discharge onto the surface of the bench.

34.6 Watertightness

Manholes must be of the pre-cast concrete or poured-in-place concrete type. Manholes must be waterproofed on the exterior. Pre-cast concrete manhole sections manufactured in accordance with ASTM C 478M-93 (with Section 16 rejection requirements made mandatory) are exempt from the exterior waterproofing requirement.

Inlet and outlet pipes must be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.

34.7 Inspection and Testing

The specifications must include a requirement for inspection and testing for watertightness or damage prior to placing into service.

34.8 Corrosion Protection for Manholes

Where corrosive conditions due to septicity or other causes is anticipated, consideration must be given to providing corrosion protection on the interior of the manholes.

34.9 Electrical

Electrical equipment installed or used in manholes must conform to Section 42.35.

35. INVERTED SIPHONS

Inverted siphons should not have less than two barrels, with a minimum pipe size of 6 inches (152 mm). They must be provided with necessary appurtenances for maintenance, convenient flushing, and cleaning equipment. The inlet and discharge structures must have adequate clearances for cleaning equipment, inspection, and flushing. Design must provide sufficient head and appropriate pipe sizes to secure velocities of at least 3.0 feet per second (0.92 m/s) for design average flows. The inlet and outlet details must be arranged so that the design average flow is diverted to one barrel, and so that either barrel may be cut out of service for cleaning. The vertical alignment should permit cleaning and maintenance.

36. SEWERS IN RELATION TO STREAMS

36.1 Location of Sewers in Streams

36.11 Cover Depth

The top of all sewers entering or crossing streams must be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, the following cover requirements must be met:

a. One foot (305 mm) of cover where the sewer is located in rock;

b. Three feet (914 mm) of cover in other material. In major streams, more than three feet (914 mm) of cover may be required; and

c. In paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement.

Less cover will be approved only if the proposed sewer crossing will not interfere with the future improvements to the stream channel. Reasons for requesting less cover must be provided in the project proposal.

36.12 Horizontal Location

Sewers located along streams must be located outside of the stream bed and sufficiently removed from the stream bed to provide for future possible stream widening and to prevent pollution by siltation during construction.

36.13 Structures

The sewer outfalls, headwalls, manholes, gate boxes, or other structures must be located so they do not interfere with the free discharge of flood flows of the stream.

36.14 Alignment

Sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible and must be free from change in grade. Sewer systems must be designed to minimize the number of stream crossings. Trenchless construction technologies should be considered for stream crossings to avoid the impacts of open cut construction.

36.2 Construction

36.21 Materials

Sewers entering or crossing streams may either be constructed of ductile iron pipe with restrained mechanical joints or be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench must be stone, coarse aggregate, washed gravel, or other materials that will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

36.22 Siltation and Erosion

Construction methods that will minimize siltation and erosion must be used. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Best management practices (BMP's) must be utilized during construction. Such methods must provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbing or uprooting of trees and vegetation, dumping of soil or debris, or pumping of silt-laden water into the stream. Specifications must require that cleanup, grading, seeding and planting or restoration of all work areas begin immediately after the construction has been completed. Exposed areas may not remain unprotected for more than seven days. A 124 permit, issued by the Montana Department of Fish, Wildlife and Parks and a 3A Permit, issued by DEQ must be obtained if turbidity in the stream is expected to be higher than 5 NTUs. Other permits may be required.

37. AERIAL CROSSINGS

Support must be provided for all joints in pipes utilized for aerial crossings. The supports must be designed to prevent frost heave, overturning, and settlement.

Precautions against freezing, such as insulation and increased slope, must be provided. Expansion jointing must be provided between above ground and below ground sewers. Where buried sewers change to aerial sewers, special construction techniques must be used to minimize frost heaving.

For aerial stream crossings, the impact of flood waters and debris must be considered. The bottom of the pipe should be placed no lower than the elevation of the 50 year flood. Ductile iron pipe with mechanical joints is recommended.

38. PROTECTION OF WATER SUPPL IES

When wastewater sewers are proposed in the vicinity of any water supply facilities, requirements of Circular DEQ 1 should be used to confirm acceptable isolation distances in addition to the following requirements.

38.1 Cross Connections Prohibited

There may not be any physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. A water pipe may not pass through or come in contact with any part of a sewer manhole.

38.2 Relation to Water Works Structures

Sewers may not be located within 100 feet of a public water supply well.

All existing waterworks units, such as basins, wells, or other treatment units, within 100 feet (61 m) of the proposed sewer must be shown on the engineering plans.

38.3 Relation to Water Mains

38.31 Horizontal Separation

Sewers must be laid at least 10 feet (3m) horizontally from any existing or proposed water main. The distance must be measured edge to edge.

If the proper horizontal separation as described above cannot be obtained, the design engineer shall submit a request for a deviation along with a description of the problem and justifying circumstances. If the deviation is granted, the sewer must be designed and constructed with the following minimum conditions:

a. Sewer pipe must be PVC with nominal 20-foot lengths.

b. The sewer must pass low pressure air testing in accordance with UniBell Recommended Practice UNI-B-6-90.

c. Sewer services utilizing in-line fittings and extending to at least property lines must be installed and tested in the area of the encroachment. Saddles are not acceptable.

38.32 Crossings

Sewers crossing water mains must be laid with a minimum vertical distance of 18 inches (457 mm) between the outside of the water main and the outside of the sewer. This must be the case where the water main is either above or below the sewer. The crossing must be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support must be provided for the sewer to maintain line and grade and to prevent damage to the water main.

If the proper vertical separation as described above cannot be obtained, the design engineer shall submit a request for a deviation along with a description of the problem and justifying circumstances. If the deviation is granted, the sewer must be designed and constructed with the following minimum conditions:

a. Vertical separation at crossings between water and sewer mains must be at least 6 (six) inches.

b. Sewer pipe must be PVC with nominal 20-foot lengths.

c. At crossings, one standard length of new pipe must be centered at approximately a 90 degree angle in respect to the existing pipe.

d. The sewer must pass low pressure air testing in accordance with UniBell Recommended Practice UNI-B-6-90.

e. Sewer services utilizing in-line fittings and extending to at least property lines must be installed and tested within 10 feet of the crossing. Saddles are not acceptable.

f. If the minimum separation is not viable, the water line must be relocated, and vertical separation at crossings between water and sewer mains must be at least18 (eighteen) inches.

39. SEWER SERVICES AND PLUMBING

39.1 Plumbing

Sewer services and plumbing must conform to relevant local and state plumbing codes, or to the Uniform Plumbing Code as amended by ARM 8.70.302.

CHAPTER 40
WASTEWATER PUMPING STATIONS

41. GENERAL

41.1 Flooding

Sewage pumping station structures and electrical and mechanical equipment must be protected from physical damage by the 100 year flood. Wastewater pumping stations should remain fully operational and accessible during the 25 year flood. Regulations of state and federal agencies regarding flood plain obstructions must be followed.

41.2 Accessibility and Security

The pumping station must be readily accessible by maintenance vehicles during all weather conditions. The facility should be located off the traffic way of streets and alleys. It is recommended that security fencing and access hatches with locks be provided.

41.3 Grit

Where it is necessary to pump wastewater prior to grit removal, the design of the wet well and pump station piping must receive special consideration to avoid operational problems from the accumulation of grit.

41.4 Safety

Adequate provision must be made to effectively protect maintenance personnel from hazards. Equipment for confined space entry in accordance with OSHA and regulatory agency requirements must be provided for all wastewater pumping stations. Also refer to Section 57.

42. DESIGN

42.1 Type

Wastewater pumping stations in general use fall into four types: wet well/dry well, submersible, suction lift, and screw pump.

42.2 Structures

42.21 Separation

Dry wells, including their superstructure, must be separated from the wet well. Common walls must be gas tight.

42.22 Equipment Removal

Provision must be made to facilitate removing pumps, motors, and other mechanical and electrical equipment.

42.23 Access and Safety Landings

42.231 Access

Suitable and safe means of access must be provided to dry wells, and to wet wells for persons wearing self-contained breathing apparatus. Access to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance must conform to Section 61.13. Also refer to Section 57.

42.232 Safety Landings

For built-in-place pump stations, a stairway or ladder to the dry well must be provided with rest landings at vertical intervals not to exceed 12 feet (3.7 m). For factory-built pump stations over 15 feet (4.6 m) deep, rigidly fixed landings must be provided at vertical intervals not to exceed 10 feet (3 m). Where a landing is used, a suitable and rigidly fixed barrier must be provided to prevent an individual from falling past the intermediate landing to a lower level. A manlift or elevator may be used in lieu of landings in a factory-built station, provided emergency access is included in the design. Where ladders are used, adherence to federal safety standards is mandatory.

42.24 Buoyancy

Where high groundwater conditions are anticipated, buoyancy of the wastewater pumping station structures must be considered and, if necessary, adequate provisions must be made for protection.

42.25 Construction Materials

Wastewater pumping stations must be constructed with materials that are capable of withstanding prolonged exposure to hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in wastewater. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided. If dissimilar metals are used, construction methods must minimize galvanic action through other means.

42.3 Pumps and Pneumatic Ejectors

42.31 Multiple Units

Multiple pumps or ejector units must be provided, Where only two units are provided, they must be of the same size. Units must have capacity such that, with any unit out of service, the remaining units will have capacity to handle the design peak hourly flow.

42.32 Protection Against Clogging

42.321 Combined Wastewater

Pumps handling combined wastewater must be preceded by readily accessible bar racks to protect the pumps from clogging or damage. Bar racks should have clear openings as provided in Section 61.121. Where a bar rack is provided, a mechanical hoist must also be provided. Where the size of the installation warrants, mechanically cleaned and/or duplicate bar racks must be provided.

42.322 Separate Sanitary Wastewater

Pumps handling separate sanitary wastewater from 30 inch (762 mm) or larger diameter sewers must be protected by bar racks meeting the above requirements. Appropriate protection from clogging must also be considered for small pumping stations. Refer to Sections 42.231 and 61.13.

42.33 Pump Openings

Pumps handling raw wastewater must be capable of passing spheres of at least 3 inches (76 mm) in diameter. Pump suction and discharge piping must be at least 4 inches (102 mm) in diameter.

42.34 Priming

The pump must be placed so that under normal operating conditions it will operate under a positive suction head, except as specified in Section 43.

42.35 Electrical Equipment

Electrical systems and components (e.g., motors, lights, cables, conduits, switch boxes, control circuits, etc.) in raw wastewater wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, must comply with the National Electrical Code requirements for Class I Group D, Division 1 locations. In addition, equipment located in the wet well must be suitable for use under corrosive conditions. Each flexible cable must be provided with watertight seal and separate strain relief. A fused disconnect switch located above ground must be provided for the main power feed for all pumping stations. When such equipment will be exposed to weather, it must meet the requirements for weatherproof equipment in NEMA 3R or 4. A 110 volt power receptacle to facilitate maintenance must be provided inside the control panel for lift stations that have control panels outdoors. Ground fault interruption protection must be provided for all outdoor outlets.

42.36 Intake

Each pump should have an individual intake. Wet well and intake design must avoid turbulence near the intake and prevent vortex formation.

42.37 Dry Well Dewatering

A sump pump equipped with dual check valves must be provided in the dry well to remove leakage or drainage, with discharge above the maximum high water level of the wet well or as necessary to prevent flooding of the dry well. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal leakage must be piped or channeled directly to the sump. The sump pump must be sized to remove the maximum pump seal water discharge that would occur from a pump seal failure. Refer to Section 45.

42.38 Pumping Rates

The pumps and controls of main pumping stations and especially pumping stations operated as part of the treatment works, should be selected to operate at varying delivery rates. Insofar as is practicable, such stations should be designed to deliver as uniform a flow as practicable in order to minimize hydraulic surges. The station design peak hourly flow capacity must be determined in accordance with Section 11.24 and should be adequate to maintain a minimum velocity of 2 feet per second (0.61 m/s) in the force main. Refer to Section 48.1.

42.4 Controls

Control float tubes, bubbler lines, or other controls should be so located as not to be unduly affected by turbulent flows entering the well or by the turbulent suction of the pumps. Provision must be made to automatically alternate the pumps in use.

42.5 Valves

42.51 Suction Line

Shutoff valves must be placed on the suction line of dry pit pumps.

42.52 Discharge Line

Shutoff and check valves must be placed on the discharge line of each pump (except on screw pumps). The check valve must be located between the shutoff valve and the pump. Check valves must be suitable for the material being handled and must be placed on the horizontal portion of discharge piping except for ball checks, which may be placed in the vertical run. Valves must be capable of withstanding normal pressure and water hammer.

All shutoff and check valves must be operable from the floor level and accessible for maintenance. Outside levers are recommended on swing check valves.

42.6 Wet Wells

42.61 Divided Wells

Where continuity of pumping station operation is critical, consideration should be given to dividing the wet well into two sections, properly interconnected, to facilitate repairs and cleaning.

42.62 Size

The design fill time and minimum pump cycle time must be considered in sizing the wet well. The effective volume of the wet well must be based on design average flow and a filling time not to exceed 30 minutes unless the facility is designed to provide flow equalization. The pump manufacturer's duty cycle recommendations must be utilized in selecting the minimum cycle time. When the anticipated initial flow tributary to the pumping station is less than the design average flow, provisions should be made so that the fill time indicated is not exceeded for initial flows. When the wet well is designed for flow equalization as part of a treatment plant, provisions should be made to prevent septicity.

42.63 Floor Slope

The wet well floor must have a slope of at least 1 to 1 to the hopper bottom. The horizontal area of the hopper bottom may not be greater than necessary for proper installation and function of the inlet.

42.64 Air Displacement

Covered wet wells must have provisions for air displacement such as an inverted "j" tube or other means which vents to the outside.

42.7 Safety Ventilation

42.71 General

Adequate ventilation must be provided for all pump stations. Where the dry well is below the ground surface, permanent mechanical ventilation is required. If screens or mechanical equipment requiring maintenance or inspection are located in the wet well, permanently installed ventilation is required. There may not be any interconnection between the wet well and dry well ventilation systems.

42.72 Air Inlets and Outlets

In dry wells over 15 feet (4.6 m) deep, multiple inlets and outlets are desirable. Dampers should not be used on exhaust or fresh air ducts and fine screen or other obstructions in air ducts should be avoided to prevent clogging.

42.73 Electrical Controls

Switches for operation of ventilation equipment should be marked and located conveniently. All intermittently operated ventilation equipment must be interconnected with the respective pit lighting system. Consideration should be given also to automatic controls where intermittent operation is used. The manual lighting ventilation switch must override the automatic controls.

42.74 Fans, Heating, and Dehumidification

The fan wheel should be fabricated from non-sparking material. Automatic heating and dehumidification equipment must be provided in all dry wells.

42.75 Wet Wells

Wet well ventilation may be either continuous or intermittent. Ventilation, if continuous, must provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour must be provided. Air must be forced into the wet well by mechanical means rather than exhausted from the wet well. Portable ventilation equipment must be provided for use at submersible pump stations and wet wells with no permanently installed ventilation equipment.

42.76 Dry Wells

Dry well ventilation may be either continuous or intermittent. Ventilation, if continuous, must provide at least 6 complete air changes per hour; if intermittent, at least 30 complete air changes per hour must be provided.

A system of two speed ventilation with an initial ventilation rate of 30 changes per hour for 10 minutes and automatic switch over to 6 changes per hour may be used to conserve heat.

42.8 Flow Measurement

Suitable devices for measuring wastewater flow should be considered at all pumping stations. Indicating, totalizing, and recording flow measurement must be provided at pumping stations with a 1200 gpm (76 L/s) or greater design peak flow. Elapsed time meters must be provided for all pumps. Flow meters must be installed in straight sections of pipe when recommended by the manufacturer.

42.9 Water Supply

There may not be any physical connection between any potable water supply and a wastewater pumping station that under any conditions might cause contamination of the potable water supply. If a potable water supply is brought to the station, it must conform to Section 56.23.

43. SUCTION LIFT PUMP STATION

43.1 Pump Priming and Lift Requirements

Suction lift pumps must be of the self-priming or vacuum-priming type and must meet the applicable requirements of Section 42. Suction-lift pump stations using dynamic suction lifts exceeding the limits outlined in the following sections may be approved upon submission of factory certification of pump performance and detailed calculations indicating satisfactory performance under the proposed operating conditions. Such detailed calculations must include static suction-lift as measured from "lead pump off" elevation to center line of pump suction, friction, and other hydraulic losses of the suction piping, vapor pressure of the liquid, altitude correction, required net positive suction head, and a safety factor of at least 6 feet (1.8 m).

The pump equipment compartment must be above grade or offset and must be effectively isolated from the wet well to prevent the humid and corrosive sewer atmosphere from entering the equipment compartment. Wet well access may not be through the equipment compartment and must be at least 24 inches (610 mm) in diameter. Gasketed replacement plates must be provided to cover the opening to the wet well for pump units removed for servicing. Valving may not be located in the wet well.

43.11 Self-Priming Pumps

Self-priming pumps must be capable of rapid priming and repriming at the "lead pump on" elevation. Such self-priming and repriming must be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and may not exceed 25 feet (7.6 m) in total length. Priming lift at the "lead pump on" elevation must include a safety factor of at least 4 feet (1.2 m) from the maximum allowable priming lift for the specific equipment at design operating conditions. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions may not exceed 22 feet (6.7 m).

43.12 Vacuuming-Priming Pumps

Vacuum-priming pump stations must be equipped with dual vacuum pumps capable of automatically and completely removing air from the suction-lift pump. The vacuum pumps must be adequately protected from damage due to wastewater. The combined total of dynamic suction-lift at the "pump off" elevation and required net positive suction head at design operating conditions may not exceed 22 feet (6.7 m).

44. SUBMERSIBLE PUMP STATIONS - SPECIAL CONSIDERATIONS

Submersible pump stations must meet the applicable requirements under Section 42, except as modified in this Section.

44.1 Construction

Submersible pumps and motors must be designed specifically for raw wastewater use, including totally submerged operation during a portion of each pumping cycle, and must meet the requirements of the National Electrical Code for such units. An effective method to detect shaft seal failure or potential seal failure must be provided.

44.2 Pump Removal

Submersible pumps must be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.

44.3 Electrical

44.31 Power Supply and Control

Electrical supply, control, and alarm circuits must be designed to provide strain relief and to allow disconnection from outside the wet well. Terminals and connectors must be protected from corrosion by location outside the wet well or through use of watertight seals. If located outside, weatherproof equipment must be used.

44.32 Controls

The motor control center must be located outside the wet well, be readily accessible, and be protected by a conduit seal or other appropriate measures meeting the requirements of the National Electrical Code, to prevent the atmosphere of the wet well from gaining access to the control center. The seal must be located so that the motor may be removed and electrically disconnected without disturbing the seal.

44.33 Power Cord

Pump motor power cords must be designed for flexibility and serviceability under conditions of extra hard usage and must meet the requirements of the National Electrical Code standards for flexible cords in wastewater pump stations. Ground fault interruption protection must be used to de-energize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings must be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable, must be provided with strain relief appurtenances, and must be designed to facilitate field connecting.

44.4 Valves

Valves required under Section 42.5, must be located in a separate valve pit. Valve pits may be dewatered to a wet well through a valved drain line. Check valves that are integral to the pump need not be located in a separate valve pit provided that the valve can be removed from the wet well in accordance with Section 44.2.

45. ALARM SYSTEMS

Alarm systems must be provided for pumping stations. The alarm must be activated upon power failure, sump pump failure, high wet well level, pump failure, unauthorized entry, or any cause of pump station malfunction. Redundant low-level alarms, or thermal sensors on pump motors, should be considered in high hazard situations to prevent explosive situations. Pumping station alarms must be telemetered to a municipal facility that is manned 24 hours a day. If such a facility is not available and a 24-holding capacity is not provided, the alarm must be telemetered to city offices during normal working hours and to the home of the responsible person(s) in charge of the lift station during off-duty hours. Audio-visual alarm systems with a self-contained power supply may be acceptable in some cases in lieu of the telemetering system outlined above, depending upon location, station holding capacity and inspection frequency.

46. EMERGENCY OPERATION

46.1 Objective

The objective of any emergency operation is to prevent the discharge of raw or partially treated wastewater to any waters and to protect public health by preventing back-up of wastewater and subsequent discharge to basements, streets, and other public and private property.

46.2 Emergency Pumping Capability

Emergency pumping capability is required unless on-system overflow prevention is provided by adequate storage capacity. Emergency pumping capability may be accomplished by connection of the station to at least two independent utility substations, or by provision of portable or in-place internal combustion engine equipment which will generate electrical or mechanical energy, or by the provision of portable pumping equipment. Such emergency standby systems must have sufficient capacity to start up and maintain the total rated running capacity of the station. A riser from the force main with rapid connection capabilities and appropriate valving should be provided for all lift stations to hook up portable pumps.

46.3 Emergency High Level Overflows

For use during possible periods of extensive power outages, mandatory power reductions, or uncontrollable emergency conditions, consideration should be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency power generation in order to prevent backup of wastewater into basements, or other discharges which may cause severe adverse impacts on public interests, including public health and property damage. Where a high level overflow is utilized, it will be necessary to install a storage/detention tank, or basin, which must be made to drain to the station wet well.

46.4 Equipment Requirements

46.41 General

The following general requirements apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives, or electrical generating equipment:

46.411 Engine Protection

The engine must be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is planned, protective equipment must be capable of shutting down the engine and activating an alarm on site and as provided in Section 45. Protective equipment must monitor for conditions of low oil pressure and overheating, except that oil pressure monitoring is not required for engines with splash lubrication.

46.412 Size

The engine must have adequate rated power to start and continuously operate under all connected loads.

46.413 Fuel Type

Reliability and ease of starting, especially during cold weather conditions, should be considered in the selection of the type of fuel.

46.414 Design and Installation of Fuel Storage Tanks

Design and installation of fuel storage tanks must comply with all state and federal standards.

46.415 Engine Ventilation

The engine must be located above grade with adequate ventilation of fuel vapors and exhaust gases.

46.416 Routine Start-up

All emergency equipment must be provided with instructions indicating the need for regular starting and running of such units at full loads.

46.417 Protection of Equipment

Emergency equipment must be protected from damage at the restoration of regular electrical power.

46.42 Engine-Driven Pumping Equipment

Where permanently-installed or portable engine-driven pumps are used, the following requirements, in addition to general requirements, apply:

46.421 Pumping Capacity

Engine-driven pump(s) must meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity. Pumps must be designed for anticipated operating conditions, including suction lift if applicable.

46.422 Operation

The engine and pump must be equipped to provide automatic start-up and operation of pumping equipment unless manual start-up and operation is justified. Provisions must also be made for manual start-up. Where manual start-up and operation is justified, storage capacity and alarm system must meet the requirements of Section 46.423.

46.423 Portable Pumping Equipment

Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity and an alarm system must be provided to allow time for detection of pump station failure and transportation and hookup of the portable equipment.

46.43 Engine-Driven Generating Equipment

Where permanently-installed or portable engine-driven generating equipment is used, the following requirements apply in addition to the general requirements of Section 46.41:

46.431 Generating Capacity

a. Generating unit size must be adequate to provide power for pump motor starting current and for lighting, ventilation, and other auxiliary equipment necessary for safety and proper operation of the lift station.

b. The operation of only one pump during periods of auxiliary power supply must be justified. Such justification may be made on the basis of the design peak hourly flows relative to single-pump capacity, anticipated length of power outage, and storage capacity.

c. Special sequencing controls must be provided to start pump motors unless the generating equipment has capacity to start all pumps simultaneously with auxiliary equipment operating.

46.432 Operation

Provisions must be made for automatic and manual start-up and load transfer unless only manual start-up and operation is justified. The generator must be protected from operating conditions that would result in damage to equipment. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity and alarm system must meet the requirements of Section 46.433.

46.433 Portable Generating Equipment

Where portable generating equipment or manual transfer is provided, sufficient storage capacity and an alarm system must be provided to allow time for detection of pump station failure and transportation and connection of generating equipment. The use of special electrical connections and double throw switches is recommended for connecting portable generating equipment.

47. INSTRUCTIONS AND EQUIPMENT

Wastewater pumping stations and portable equipment must be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, tools and such spare parts as may be necessary.

48. FORCE MAINS

48.1 Velocity and Diameter

At design pumping rates, a cleaning velocity of at least 2 feet per second (0.61 m/s) must be maintained. The minimum force main diameter for raw wastewater is 4 inches (102 mm). It is desirable to have cleaning velocities of at least 3 feet per second.

48.2 Air and Vacuum Relief Valve

An air relief valve must be placed at high points in the force main to prevent air locking. Vacuum relief valves may be necessary to relieve negative pressures on force mains. The force main configuration and head conditions should be evaluated as to the need for and placement of vacuum relief valves.

48.3 Termination

Force mains should enter the gravity sewer system at a point not more than 2 feet (610 mm) above the flow line of the receiving manhole.

48.4 Pipe and Design Pressure

Pipe and joints must be equal to water main strength materials suitable for design conditions. The force main, reaction blocking, and station piping must be designed to withstand water hammer pressures and associated cyclic reversal of stresses that are expected with the cycling of wastewater lift stations. Surge protection chambers should be evaluated.

48.5 Special Construction

Force main construction near streams or water works structures and at water main crossings must meet applicable provisions of Sections 36, 37, and 38.

48.6 Freeze Prevention

Force mains must be constructed to prevent freezing and must be buried a minimum of 6 feet. Depths greater than 6 feet may be required where local conditions dictate. If it is impossible to achieve sufficient burial depth, insulation may be used to help prevent freezing. However, when proper depth cannot be obtained, the engineer shall submit justification for the lesser depth and heat flow calculations showing that the pipe will not freeze.

48.7 Design Friction Losses

48.71 Friction Coefficient

Friction losses through force mains must be based on the Hazen and Williams formula or other acceptable methods. When the Hazen and Williams formula is used, the value for "C" must be 100 for unlined iron or steel pipe for design. For other smooth pipe materials such as PVC, polyethylene, lined ductile iron, etc., a higher "C" value not to exceed 120 may be allowed for design.

48.72 Maximum Power Requirements

When initially installed, force mains will have a significantly higher "C" factor. The effect of the higher "C" factor should be considered in calculating maximum power requirements and duty cycle time to prevent damage to the motor.

48.8 Identification

Where force mains are constructed of material that might cause the force main to be confused with potable water mains, the force main must be appropriately identified.

48.9 Leakage Testing

Leakage tests must be specified including testing methods and leakage limits.

CHAPTER 50
WASTEWATER TREATMENT WORKS

51. PLANT LOCATION

51.1 General

Items to be considered when selecting a plant site are listed in Chapter 10. The layout and siting of wastewater treatment facilities must consider the long-range implications of the Nondegradation Rules. Area should be set aside for future facilities that may be required to provide increased levels of treatment.

51.2 Flood Protection

The treatment works structures, and electrical and mechanical equipment must be protected from physical damage by the one hundred (100) year flood. Treatment works should remain fully operational and accessible during the twenty-five (25) year flood. This requirement applies to new construction and to existing facilities undergoing major modification. Flood plain regulations of state and federal agencies must be followed.

52. QUALITY OF EFFLUENT

The required degree of wastewater treatment must be based on the effluent requirements and water quality standards established by the DEQ and/or appropriate federal regulations including discharge permit requirements.

53. DESIGN

53.1 Type of Treatment

Items that must be considered in the selection of the appropriate type of treatment are presented in Chapter 10.

The plant design must provide the necessary flexibility to perform satisfactorily within the expected range of waste characteristics and volumes.

53.2 Required Engineering Data for New Process and Application Evaluation

The policy of the reviewing authority is to encourage rather than obstruct the development of any methods or equipment for treatment of wastewaters. The lack of inclusion in these standards of some types of wastewater treatment processes or equipment should not be construed as precluding their use. The reviewing authority may approve other types of wastewater treatment processes and equipment if the operational reliability and effectiveness of the process or device has been demonstrated with a suitably-sized prototype unit operating at its design load conditions, to the extent required.

To determine that such new processes and equipment or applications have a reasonable and substantial chance of success, the reviewing authority may require the following:

a. Monitoring observations, including test results and engineering evaluations, demonstrating the efficiency of such processes;

b. Detailed description of the test methods;

c. Testing, including appropriately-composited samples, under various ranges of strength and flow rates (including diurnal variations) and waste temperatures over a sufficient length of time to demonstrate performance under climatic and other conditions which may be encountered in the area of the proposed installations;

d. Other appropriate information.

The reviewing authority may require that appropriate testing be conducted and evaluations be made under the supervision of a competent process engineer other than those employed by the manufacturer or developer.

53.3 Design Period

The design period must be clearly identified in the engineering report or facilities plan as required in Chapter 10.

53.4 Design Loads

53.41 Hydraulic Design

53.411 Critical Flow Conditions

Flow conditions critical to the design of the treatment plant are described in Chapter 10.

Initial low flow conditions must be evaluated in the design to minimize operational problems with freezing, septicity, flow measurements and solids dropout. The design peak hourly flows must be considered in evaluating unit processes, pumping, piping, etc.

53.412 Treatment Plant Design Capacity

The treatment plant design capacity must be as described in Chapter 10. The plant design flow selected must meet the appropriate effluent and water quality standards that are set forth in the discharge permit. The design of treatment units that are not subject to peak hourly flow requirements must be based on the design average flow. For plants subject to high wet weather flows or overflow detention pumpback flows, the design maximum day flows that the plant is to treat on a sustained basis should be specified.

53.413 Flow Equalization

Facilities for the equalization of flows and organic shock load must be considered at all plants that are critically affected by surge loadings. The sizing of the flow equalization facilities should be based on data obtained herein and from Chapter 10.

53.42 Organic Design

Organic loadings for waste treatment plant design must be based on the information given in Chapter 10. The effects of septage flow that may be accepted at the plant must be given consideration and appropriate facilities must be included in the design. Refer to Appendix A.

53.43 Shock Effects

The shock effects of high concentrations and diurnal peaks for short periods of time on the treatment process, particularly for small treatment plants, must be considered.

53.5 Conduits

All piping and channels should be designed to carry the maximum expected flows. The incoming sewer should be designed for unrestricted flow. Bottom corners of the channels must be filleted. Conduits must be designed to avoid creation of pockets and corners where solids can accumulate.

Suitable gates or valves should be placed in channels to seal off unused sections, which might accumulate solids. The use of shear gates, stop plates or stop planks is permitted where they can be used in place of gate valves or sluice gates. Non-corrodible materials must be used for these control gates.

53.6 Arrangement of Units

Component parts of the plant should be arranged for greatest operating and maintenance convenience, flexibility, economy, continuity of maximum effluent quality, and ease of installation of future units.

53.7 Flow Division Control

Flow division control facilities must be provided as necessary to insure organic and hydraulic loading control to plant process units and must be designed for easy operator access, change, observation and maintenance. The use of head boxes equipped with adjustable sharp-crested weirs or similar devices is recommended. The use of valves for flow splitting is not recommended. Appropriate flow measurement facilities must be incorporated in the flow division control design.

54. PLANT DETAILS

54.1 Installation of Mechanical Equipment

The specifications should be so written that the installation and initial operation of major items of mechanical equipment will be inspected and approved by a representative of the manufacturer.

54.2 Unit Bypasses

54.21 Removal From Service

Properly located and arranged bypass structures and piping must be provided so that each unit of the plant can be removed from service independently. The bypass design must facilitate plant operation during unit maintenance and emergency repair to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode.

Bypassing may be accomplished through the use of duplicate or multiple treatment units in any stage.

54.22 Unit Bypass During Construction

Unit bypassing during construction must conform to the requirements in Sections 11.29 (h), 20.15 and Section 21.

54.3 Unit Dewatering, Flotation Protection, and Plugging

Means such as drains or sumps must be provided to completely dewater each unit to an appropriate point in the process. Due consideration must be given to the possible need for hydrostatic pressure relief devices to prevent flotation of structures. Pipes subject to plugging must be provided with means for mechanical cleaning or flushing.

54.4 Construction Materials

Due consideration must be given to the selection of materials that are to be used in wastewater treatment works because of the possible presence of hydrogen sulfide and other corrosive gases, greases, oils, and similar constituents frequently contained in wastewater. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action.

54.5 Painting

The use of paints containing lead or mercury should be avoided, in order to facilitate identification of piping, particularly in the large plants, it is suggested that the different lines be color-coded. The following color scheme is recommended for purposes of standardization.

Raw sludge line - brown with black bands
Sludge recirculation suction line - brown with yellow bands
Sludge draw off line - brown with orange bands
Sludge recirculation discharge line - brown
Sludge gas line - orange (or red)
Natural gas line - orange (or red) with black bands
Nonpotable water line - blue with black bands
Potable water line - blue
Chlorine line - yellow
Sulfur Dioxide - yellow with red bands
Sewage (wastewater) line - gray
Compressed air line - green
Water lines for heating digesters or buildings - blue with a 6-inch (152 mm) red band spaced 30 inches (762 mm) apart.

The contents and direction of flow must be stenciled on the piping in a contrasting color.

54.6 Operating Equipment

A complete outfit of tools, accessories and spare parts necessary for the plant operator's use must be provided. Readily accessible storage space and workbench facilities must be provided, and consideration must be given to provision of a garage for large equipment storage, maintenance, and repair.

54.7 Erosion Control Construction

Effective site erosion control must be provided during construction.

54.8 Grading and Landscaping

Upon completion of the plant, the ground must be graded and sodded or seeded. All-weather walkways should be provided for access to all units. Where possible, steep slopes should be avoided to prevent erosion. Surface water may not be permitted to drain into any unit. Particular care must be taken to protect trickling filter beds, sludge beds, and intermittent sand filters from stormwater runoff. Provision should be made for landscaping, particularly when a plant must be located near residential areas.

55. PLANT OUTFALLS

55.1 Discharge Impact Control

The outfall sewer must be designed to discharge to the receiving stream in a manner acceptable to the reviewing authority. Consideration should be given in each case to the following:

a. Preference for free fall or submerged discharge at the site selected;

b. Utilization of cascade aeration of effluent discharge to increase dissolved oxygen; and

c. Limited or complete across-stream dispersion as needed to protect aquatic life movement and growth in the immediate reaches of the receiving stream.

55.2 Protection and Maintenance

The outfall sewer must be so constructed and protected against the effects of floodwater, tide, ice, or other hazards as to reasonably insure its structural stability and freedom from stoppage. A manhole should be provided at the shore end of all gravity sewers extended into the receiving waters. Hazards to navigation must be considered in designing outfall sewers.

55.3 Sampling Provisions

All outfalls must be designed so that a sample of the effluent can be safely obtained at a point after the final treatment process and before discharge to or mixing with the receiving waters.

56. ESSENTIAL FACILITIES

56.1 Emergency Power Facilities

56.11 General

All plants must be provided with an alternate source of electric power or pumping capability to allow continuity of operation during power failures, except as noted below. Methods of providing alternate sources include:

a. The connection of at least two independent power sources such as substations. A power line from each substation is recommended, and will be required unless documentation is received and approved by the reviewing authority verifying that a duplicate line is not necessary;

b. Portable or in-place internal combustion engine equipment which will generate electrical or mechanical energy; and

c. Portable pumping equipment when only emergency pumping is required.

56.12 Power for Aeration

Standby generating capacity normally is not required for aeration equipment used in the activated sludge process. In cases where a history of long-term (4 hours or more) power outages have occurred, auxiliary power for minimum aeration of the activated sludge will be required. Full power generating capacity may be required by the reviewing authority for waste discharges to certain critical stream segments such as upstream of bathing beaches, public water supply intake or other similar situations.

56.13 Power for Disinfection

Continuous disinfection, where required, must be provided during all power outages. Continuous dechlorination is required for those systems that dechlorinate.

56.2 Water Supply

56.21 General

An adequate supply of potable water under pressure should be provided for use in the laboratory and for general cleanliness around the plant. Piping or other connections may not exist in any part of the treatment works, which, under any conditions, might cause the contamination of a potable water supply. The chemical quality should be checked for suitability for its intended uses such as in heat exchangers, chlorinators, etc.

56.22 Direct Connections

Potable water from a municipal or separate supply may be used directly at points above grade for the following hot and cold supplies:

a. Lavatory;

b. Water closet;

c. Laboratory sink (with vacuum breaker);

d. Shower;

e. Drinking fountain;

f. Eye wash fountain; and

g. Safety shower.

Hot water for any of the above units may not be taken directly from a boiler used for supplying hot water to a sludge heat exchanger or digester heating unit.

56.23 Indirect Connections

Where a potable water supply is to be used for any purpose in a plant other than those listed in Section 56.22, either a combination of a break tank, pressure pump, and pressure tank, must be used, or a backflow preventer valve must be installed. Water must be discharged to the break tank through an air gap at least 6 inches (15.2 cm) above the flood line or the spill line of the tank, whichever is higher. Air gaps and backflow preventer valves must be constructed in accordance with the Uniform Plumbing Code. If backflow preventer valves are used the plant must have a backflow prevention program approved by the DEQ. Also the requirements of this Circular, Sections 38.1, "Cross Connections Prohibited," and 38.2, "Relation to Water Works Structures," apply.

A sign must be permanently posted at every hose bib, faucet, hydrant or sill cock located on the water system beyond the break tank or approved backflow prevention assembly to indicate that the water is not safe for drinking.

56.24 Separate Potable Water Supply

Where it is not possible to provide potable water from a public water supply, a separate well may be provided. Location and construction of the well should be in compliance with DEQ Circular DEQ 3 or the Water Well Contractors' rules, depending upon the population to be served. Requirements governing the use of the supply are those contained in Sections 56.22 and 56.23.

56.25 Separate Non-Potable Water Supply

Where a separate non-potable water supply is to be provided a break tank or approved backflow prevention assembly will not be necessary, but all system outlets must be posted with a permanent sign indicating the water is not safe for drinking.

56.3 Sanitary Facilities

Toilet, shower, lavatory, and locker facilities should be provided in sufficient numbers and convenient locations to serve the expected plant personnel.

56.4 Floor Slope

Floor surfaces must be sloped adequately to a point of drainage.

56.5 Stairways

Stairways, rather than ladders, must be installed for access to units requiring routine inspection and maintenance, such as digesters, trickling filters, aeration tanks, clarifiers, tertiary filters, etc. Spiral or winding stairs are permitted only for secondary access where dual means of egress are provided.

Stairways must have slopes between 30° and 40° from the horizontal to facilitate carrying samples, tools, etc. Each tread and riser must be of uniform dimension in each flight. Minimum tread run is 9 inches (229 mm). The sum of the tread run and riser may not be less than 17 (432 mm) nor more than 18 inches (457 mm). A flight of stairs may consist of no more than a 12-foot (3.7 m) continuous rise without a platform.

56.6 Flow Measurement

56.61 Location

Flow measurement facilities must be provided to measure the following flows:

a. Plant influent and effluent flow;

b. Excess flow treatment facility discharges;

c. Other flows required to be monitored under the provisions of the discharge permit; and

d. Other flows, such as return activated sludge, waste activated sludge, recirculation, and recycle required for plant operational control.

56.62 Facilities

Indicating, totalizing and recording flow measurement devices must be provided for all mechanical plants. Flow measurement facilities for lagoon systems must be at least equivalent to elapsed time meters used in conjunction with pumping rate tests or calibrated weirs or flumes. All flow measurement equipment must be sized to function effectively over the full range of flows expected, must be protected against freezing and must be readily accessible.

56.63 Hydraulic Conditions

Flow measurement equipment including entrance and discharge conduit configuration and critical control elevations must be designed to ensure that the required hydraulic conditions necessary for accurate measurement are provided. Conditions that must be avoided include turbulence, eddy currents, air entrainment, etc., that upset the normal hydraulic conditions that are necessary for accurate flow measurement.

56.7 Sampling Equipment

Effluent composite sampling equipment must be provided at facilities where necessary to meet discharge permit monitoring requirements. Composite sampling equipment must also be provided as needed for influent sampling and for monitoring plant operations.

57. SAFETY

57.1 General

Adequate provision must be made to effectively protect the operator and visitors from hazards. The following must be provided:

a. Enclosure of the plant with a fence and signs designed to discourage the entrance of unauthorized persons and animals;

b. Hand rails and guards around tanks, trenches, pits, stairwells, and other hazardous structures with the tops of walls less than 42 inches above the surrounding ground level;

c. Gratings over appropriate areas of treatment units where access for maintenance is required;

d. First aid equipment;

e. "No Smoking" signs in hazardous areas;

f. Protective clothing and equipment, such as self-contained breathing apparatus, gas detection equipment, goggles, gloves, hard hats, safety harnesses, etc.;

g. Portable blower and sufficient hose;

h. Portable lighting equipment complying with the National Electrical Code requirements;

i. Gas detectors certified for use in Class I, Group D, Division 1 locations;

j. Appropriately-placed warning signs for slippery areas, non-potable water fixtures, low head clearance areas, open service manholes, hazardous chemical storage areas, flammable fuel storage areas, etc.;

k. Adequate ventilation in pump station areas in accordance with Section 42.7;

l. Provisions for local lockout on stop motor controls, main power source; and

m. Provisions for confined space entry in accordance with OSHA and regulatory agency requirements.

57.2 Hazardous Chemical Handling

Follow OSHA Hazard Communication Standard, found in Title 29 Code of Federal Regulations (CFR) Part 1910.1200, or Worker Right to Know Law. In addition, see Uniform Fire Code Article 80.

57.21 Containment Materials

The materials utilized for storage, piping, valves, pumping, metering, splash guards, etc., must be specially selected considering the physical and chemical characteristics of each hazardous or corrosive chemical.

57.22 Underground Storage

Underground storage and piping facilities for fuels or for chemicals such as alum or ferric chloride must be constructed in accordance with applicable state and federal regulations on underground storage tanks for both fuels and hazardous materials.

57.23 Secondary Containment

Chemical storage areas must be enclosed in dikes or curbs that will contain the stored volume until it can be safely transferred to alternate storage or released to the wastewater at controlled rates that will not damage facilities, inhibit the treatment process, or contribute to stream pollution. Liquid polymer should be similarly contained to reduce areas with slippery floors, especially to protect travelways. Non-slip floor surfaces are desirable in polymer-handling areas.

57.24 Liquefied Gas Chemicals

Properly designed isolated areas must be provided for storage and handling of chlorine and sulfur dioxide and other hazardous gases. Gas detection kits, alarms, controls, safety devices, and emergency repair kits must also be provided.

57.25 Splash Guards

All pumps or feeders for hazardous or corrosive chemicals must have guards that will effectively prevent spray of chemicals into space occupied by personnel. The splash guards are in addition to guards to prevent injury from moving or rotating machinery parts.

57.26 Piping, Labeling, Coupling Guards, Location

All piping containing or transporting corrosive or hazardous chemicals must be identified with labels every ten feet and with at least two labels in each room, closet, or pipe chase. Color-coding may also be used, but is not an adequate substitute for labeling.

All connections (flanged or other type), except those adjacent to storage or feeder areas, must have guards that will direct any leakage away from space occupied by personnel. Pipes containing hazardous or corrosive chemicals should not be located above shoulder level except where continuous drip collection trays and coupling guards will eliminate chemical spray or dripping onto personnel.

57.27 Protective Clothing and Equipment

The following items of protective clothing or equipment must be provided and utilized for all operations or procedures when their use will minimize injury hazard to personnel:

a. Self-contained breathing apparatus recommended for protection against chlorine;

b. Chemical worker's goggles or other suitable goggles (safety glasses are insufficient);

c. Face masks or shields for use over goggles;

d. Dust mask to protect the lungs in dry chemical areas;

e. Rubber gloves;

f. Rubber aprons with leg straps;

g. Rubber boots (leather and wool clothing should be avoided near caustics); and

h. Safety harness and line.

57.28 Warning System and Signs

Facilities must be provided for automatic shutdown of pumps and sounding of alarms when failure occurs in a pressurized chemical discharge line.

Warning signs requiring use of goggles must be located near chemical unloading stations, pumps, and other points of frequent hazard.

57.29 Dust Collection

Dust collection equipment must be provided to protect personnel from dusts injurious to the lungs or skin and to prevent polymer dust from settling on walkways which become slick when wet.

57.3 Hazardous Chemical Container Identification

The identification and hazard warning data included on shipping containers must appear on all containers (regardless of size or type) used to store, carry, or use a hazardous substance. Wastewater and sludge sample containers should be adequately labeled. Below is a suitable label to identify a wastewater sample as a hazardous substance:

RAW SEWAGE WASTEWATER

Sample point No. ___________________

Contains Harmful Bacteria.

May contain hazardous or toxic material.

Do not drink or swallow.

Avoid contact with openings or breaks in the skin.

58. LABORATORY

Follow OSHA Laboratory Safety Standard found in Title 29 CFR Part 1910.1450.

58.1 General

All treatment works must include a laboratory for making the necessary analytical determinations and operating control tests, except for those plants utilizing only processes not requiring laboratory testing for plant control and where satisfactory off-site laboratory provisions are made to meet the permit monitoring requirements. For plants where a fully equipped laboratory is not required, the requirements for utilities, fume hoods, etc., may be reduced. The laboratory must have sufficient size, bench space, equipment, and supplies to perform all self-monitoring analytical work required by discharge permits, and to perform the process control tests necessary for good management of each treatment process included in the design.

The facilities and supplies necessary to perform analytical work to support industrial waste control programs will normally be included in the same laboratory. The laboratory arrangement should be sufficiently flexible to allow future expansion should more analytical work be needed. Laboratory instrumentation and size should reflect treatment plant size, staffing requirements, and process complexity. Experience and training of plant operators should also be assessed in determining treatment plant laboratory needs.

Treatment plant laboratory needs may be divided into the following three general categories:

I. Plants performing only basic operational testing; this typically includes pH, temperature, and dissolved oxygen.

II. Plants performing more complex operational and permit laboratory tests including biochemical oxygen demand, suspended solids, and fecal coliform analysis, and;

III. Plants performing more complex operational, permit, industrial pretreatment, and multiple plant laboratory testing.

Expected minimum laboratory needs for these three plant classifications are outlined in this Section. However, in specific cases laboratory needs may have to be modified or increased due to the industrial monitoring needs or special process control requirements.

58.2 Category I: Plants performing only basic operational testing.

58.21 Location and Space

A floor area up to 150 square feet (14 m^2) should be adequate. It is recommended that this be at the treatment site. Another location in the community utilizing space in an existing structure owned by the involved sewer authority may be acceptable.

58.22 Design and Materials

The facility must provide electricity, water, heat, sufficient storage space, a sink, and a bench top. The lab components need not be of industrial grade materials. Laboratory equipment and glassware must be of types recommended by "Standard Methods for the Examination of Water and Wastewater" and the reviewing authority.

58.3 Category II: Plants performing more complex ope rational and permit laboratory tests including biochemical oxygen demand, suspended solids, and fecal coliform analysis.

58.31 Location and Space

The laboratory size should be based on providing adequate room for the equipment to be used. In general, the laboratories for this category of plant should provide a minimum of approximately 300 square feet (28 m^2) of floor space. The laboratory should be located at the treatment site on ground level. The laboratory must be isolated away from vibrating, noisy, high-temperature machinery or equipment, which might have adverse effects on the performance of laboratory staff or instruments.

58.32 Floors

Floor surfaces should be fire resistance, and highly resistant to acids, alkalies, solvents, and salts.

58.33 Cabinets and Bench Tops

Laboratories in this category usually perform both the NPDES permit testing and operational control monitoring utilizing "acids" and "bases" in small quantities, such that laboratory grade metal cabinets and shelves are not mandatory. The cabinets and shelves selected may be of wood or other durable materials. Bench tops should be of acid resistant laboratory grade materials for protection of the non-acid proof cabinets. Glass doors on wall-hung cabinets are not required.

One or more cupboard style base cabinets should be provided. Cabinets with drawers should have stops to prevent accidental removal. Cabinets for Category II laboratories are not required to have gas, air, vacuum, and electrical service fixtures. Built-in shelves should be adjustable.

58.34 Fume Hoods, Sinks, and Ventilation

58.341 Fume Hoods

Fume hoods must be provided for laboratories in which required analytical work produces noxious fumes.

58.342 Sinks

A laboratory grade sink and drain trap must be provided.

58.343 Ventilation

Laboratories should be air conditioned. In addition, separate exhaust ventilation should be provided.

58.35 Balance and Table

An analytical balance of the automated digital readout, single pan 0.1 milligram sensitivity type, must be provided. A heavy special-design balance table, which will minimize vibration of the balance is recommended. If provided, it must be located as far as possible from windows, doors, or other sources of drafts or air movements, so as to minimize undesirable impacts from these sources upon the balance.

58.36 Equipment, Supplies, and Reagents

The laboratory must be provided with all of the equipment, supplies and reagents that are needed to carry out all of the facility's analytical testing requirements. If any required analytical testing produces malodorous or noxious fumes, the engineer should verify that the in-house analysis is more cost-effective than use of an independent off-site laboratory. Composite samplers may be required to satisfy permit sampling requirements. Discharge permit, process control, and industrial waste monitoring requirements should be considered when specifying equipment needs. References such as Standard Methods for the Examination of Water and Wastewater and the U.S.E.P.A Analytical Procedures Manual should be consulted prior to specifying equipment items.

58.37 Utilities

58.371 Power Supply

Consideration should be given to providing line voltage regulation for power supplied to laboratories using delicate instruments.

58.372 Laboratory Water

Reagent water of a purity suitable for analytical requirements must be supplied to the laboratory. In general, reagent water prepared using an all glass distillation system is adequate. However, some analyses require deionization of the distilled water. Consideration should be given to softening the feed water to the still.

58.38 Safety

58.381 Equipment

At a minimum, laboratories must provide the following: first aid equipment, protective clothing including goggles, gloves, lab aprons, etc., and a fire extinguisher.

58.382 Eyewash Fountains and Safety Showers

Eyewash fountains and safety showers utilizing potable water must be provided in the laboratory and should be as close as practical to, and no more than 25 feet (7.6 m) from points of hazardous chemical exposure.

The eyewash fountains must be supplied with water of moderate temperature, 50° to 90° F (10° to 32° C), suitable to provide 15 minutes to 30 minutes of continuous irrigation of the eyes. The emergency showers must be capable of discharging 30 to 50 gpm (1.9 to 3.2 L/s) of water at moderate temperature and at pressures of 20 to 50 psi (138 to 345 kPa).

58.4 Category III. Plants performing more complex operational, permit, industrial pretreatment and multiple plant laboratory testing.

58.41 Location and Space

The laboratory should be located at the treatment site on ground level, with environmental control as an important consideration. It must be located away from vibrating, noisy, high temperature machinery or equipment, which might have adverse effects on the performance of laboratory staff or instruments. The laboratory facility needs for Category III plants should be described in the engineering report or facilities plan. The laboratory floor space and facility layout should be based on an evaluation of the complexity, volume, and variety of sample analyses expected during the design life of the plant including testing for process control, industrial pretreatment control, user charge monitoring, and discharge permit monitoring requirements.

Consideration should be given to the necessity to provide separate (and possibly isolated) areas for some special laboratory equipment, glassware, and chemical storage. At large plants, office and administrative space needs should be considered.

For less complicated laboratory needs bench-top working surface should occupy at least 35 percent of the total laboratory floor space. Additional floor and bench space should be provided to facilitate performance of analysis of industrial wastes, as required by the discharge permit and the utility's industrial waste pretreatment program. Ceiling height should be adequate to provide for the installation of wall mounted water stills, deionizers, distillation racks, hoods, and other equipment with extended height requirements.

58.42 Floors and Doors

58.421 Floors

Floor surfaces should be fire resistant, and highly resistant to acids, alkalies, solvents, and salts.

58.422 Doors

Two exit doors should be located to permit a straight egress from the laboratory, preferably at least one to outside the building. Panic hardware should be used. They should have large glass windows for easy visibility of approaching or departing personnel.

Automatic door closers should be installed; swinging doors should not be used.

Flush hardware should be provided on doors if cart traffic is anticipated. Kick plates are also recommended.

58.43 Cabinets and Bench Tops

58.431 Cabinets

Wall-hung cabinets are useful for dust-free storage of instruments and glassware. Units with sliding glass doors are preferable. A reasonable proportion of cupboard style base cabinets and drawer units should be provided.

Drawers should slide out so that entire contents are easily visible. They should be provided with rubber bumpers and with stops, which prevent accidental removal. Drawers should be supported on ball bearings or nylon rollers, which pull easily in adjustable steel channels. All metal drawer fronts should be double-wall construction.

All cabinet shelving should be acid resistant and adjustable. The laboratory furniture must be supplied with adequate water, gas, air, and vacuum service fixtures, traps, strainers, plugs and tailpieces, and all electrical service fixtures.

58.432 Bench Tops

Bench tops should be constructed of materials resistant to attacks from normally used laboratory reagents. Generally, bench-top height should be 36 inches (914 mm). However, areas to be used exclusively for sit-down type operations should be 30 inches (762 mm) high and include kneehole space. One inch (25.4 mm) overhangs and drip grooves should be provided to keep liquid spills from running along the face of the cabinet. Tops should be furnished in large sections, 1-1/4 inches (32 mm) thick. They should be field-jointed into a continuous surface with acid, alkali, and solvent resistant cements which are at least as strong as the material of which the top is made.

58.44 Hoods

58.441 General

Fume hoods and canopy hoods over heat-releasing equipment must be provided.

58.442 Fume Hoods

a. Location

Fume hoods should be located where air disturbance at the face of the hood is minimal. Air disturbance may be created by persons walking past the hood; by heating, ventilating, or air-conditioning systems; by drafts from opening or closing a door; etc.

Safety factors should be considered in locating a hood. If a hood is situated near a doorway, a secondary means of egress must be provided. Bench surfaces should be available next to the hood so that chemicals need not be carried long distances.

b. Design and Materials

The selection, design, and materials of construction of fume hoods and their appropriate safety alarms must be made by considering the variety of analytical work to be performed. The characteristics of the fumes, chemicals, gases, or vapors that will or may be released by the activities therein should be considered. Special design and construction is necessary if perchloric acid use is anticipated. Consideration should be given to providing more than one fume hood to minimize potential hazardous conditions throughout the laboratory.

Fume hoods are not appropriate for operation of heat-releasing equipment that does not contribute to hazards, unless they are provided in addition to those needed to perform hazardous tasks.

c. Fixtures

One cup sink should be provided inside each fume hood. A cup sink is usually adequate.

All switches, electrical outlets, and utility and baffle adjustment handles should be located outside the hood. Light fixtures should be explosion-proof.

d. Exhaust

Twenty-four hour continuous exhaust capability should be provided. Exhaust fans should be explosion-proof. Exhaust velocities should be checked when fume hoods are installed.

58.443 Canopy Hoods

Canopy hoods should be installed over the bench-top areas where hot plate, steam bath, or other heating equipment or heat-releasing instruments are used. The canopy should be constructed of heat and corrosion resistant material.

58.45 Sinks, Ventilation, and Ligh ting

58.451 Sinks

The laboratory should have a minimum of two sinks (not including cup sinks). At least one of them should be a double-well sink with drainboards. Additional sinks should be provided in separate work areas as needed and identified for the use intended.

Sinks should be made of epoxy resin or plastic materials highly resistant to acids, alkalies, solvents, and salts, and should be abrasion and heat resistant, non-absorbent, and light in weight. Traps should be made of glass, plastic, or lead and easily accessible for cleaning. Waste openings should be located toward the back so that a standing overflow will not interfere.

All water fixtures on which hoses may be used should be provided with reduced zone pressure backflow preventers to prevent contamination of water lines.

58.452 Ventilation

Laboratories should be separately air conditioned, with external air supply for one hundred percent make-up volume. In addition, separate exhaust ventilation should be provided. Ventilation outlet locations should be remote from ventilation inlets. Consideration should be given to providing dehumidifiers.

58.453 Lighting

Good lighting, free from shadows, must be provided for reading dials, meniscuses, etc., throughout the laboratory.

58.46 Balance and Table

An analytical balance of the automatic, digital readout, single pan, 0.1 milligram sensitivity type, must be provided. A heavy special-design balance table that will minimize vibration of the balance is needed. The table must be located as far as practical from windows, doors, or other sources of drafts or air movements, to minimize undesirable impacts from these sources upon the balance.

58.47 Equipment, Supplies and Reagents

The laboratory must be provided with all of the equipment, supplies, and reagents that are needed to carry out all of the facility's analytical testing requirements. Composite samplers may be required to satisfy permit sampling requirements. Discharge permit, process control, and industrial waste monitoring requirements should be considered when specifying equipment needs. References such as Standard Methods for the Examination of Water and Wastewater and the U.S.E.P.A Analytical Procedures Manual should be consulted prior to specifying equipment items.

58.48 Utilities and Services

58.481 Power Supply

Consideration should be given to providing line voltage regulation for power supplied to laboratories using delicate instruments.

58.482 Laboratory Water

Reagent water of a purity suitable for analytical requirements must be supplied to the laboratory. In general, reagent water prepared using an all glass distillation system is adequate. However, some analyses require deionization of the distilled water. Consideration should be given to softening the feed water to the still.

58.483 Gas and Vacuum

Natural or LP gas should be supplied to the laboratory. Digester gas should not be used. An adequately-sized line source of vacuum should be provided with outlets available throughout the laboratory.

58.49 Safety

58.491 Equipment

Laboratories must contain the following: first aid equipment; protective clothing and equipment such as, goggles, safety glasses, full face shields, gloves, etc.; fire extinguishers; chemical spill kits; "No Smoking" signs in hazardous areas; and appropriately placed warning signs for slippery areas, non-potable water fixtures, hazardous chemical storage areas, flammable fuel storage areas, etc.

58.492 Eyewash Fountains and Safety Showers

Eyewash fountains and safety showers utilizing potable water must be provided in the laboratory and should be as close as practical to and no more than 25 feet (7.6 m) from points of hazardous chemical exposure.

The eyewash fountains must be supplied with water of moderate temperature, 50^{o} to 90^{o} F (100^{o} to 32^{o} C), suitable to provide 15 minutes to 30 minutes of continuous irrigation of the eyes. The emergency showers must be capable of discharging 30 to 50 gpm (1.9 to 3.2 L/s) of water at moderate temperature and at pressures of 20 to 50 psi (138 to 345 kPa).

CHAPTER 60
SCREENING, GRIT REMOVAL, AND FLOW EQUALIZATION

61. SCREENING DEVICES

61.1 Coarse Screens

61.11 When Required

Protection for pumps and other equipment must be provided by trash racks, coarse bar racks, or coarse screens.

61.12 Design and Installation

61.121 Bar Spacing

Clear openings between bars should be no less than one inch (25.4 mm) for manually cleaned screens. Clear openings for mechanically cleaned screens may be smaller. Maximum clear openings should be 1 3/4 inches (44.5 mm).

61.122 Slope and Velocity

Manually cleaned screens should be placed on a slope of 30 to 45 degrees from the horizontal.

At design average flow conditions, approach velocities should be no less than 1.25 feet per second (0.38 m), to prevent settling; and no greater than 3.0 fps (0.91 m/s) to prevent forcing material through the openings.

61.123 Channels

Dual channels must be provided and equipped with the necessary gates to isolate flow from any screening unit. Provisions must also be made to facilitate dewatering each unit. The channel preceding and following the screen must be shaped to eliminate stranding and settling of solids.

61.124 Auxiliary Screens

Where a single mechanically cleaned screen is used, an auxiliary manually cleaned screen must be provided. Where two or more mechanically cleaned screens are used, the design must provide for taking any unit out of service without sacrificing the capability to handle the design peak instantaneous flows.

61.125 Invert

The screen channel invert should be 3.0 to 6.0 inches (76 to 152 mm) below the invert of the incoming sewer.

61.126 Flow Distribution

Entrance channels should be designed to provide equal and uniform distribution of flow to the screens.

61.127 Backwater Effect on Flow Metering

Flow measurement devices should be selected for reliability and accuracy. The effect of changes in backwater elevation, due to intermittent cleaning of screens, should be considered in locations of flow measurement equipment.

61.128 Freezing Protection

Screening devices and screening storage areas must be protected from freezing.

61.129 Screenings Removal and Disposal

A convenient and adequate means for removing screenings must be provided. Hoisting or lifting equipment may be necessary depending on the depth of pit and amount of screenings or equipment to be lifted.

Facilities must be provided for handling, storage, and disposal of screenings in a manner acceptable to the regulatory agency. Separate grinding of screenings and return to the sewage flow is unacceptable.

Manually cleaned screening facilities must include an accessible platform from which the operator may rake screenings easily and safely. Suitable drainage facilities must be provided for both the platform and the storage area.

61.13 Access and Ventilation

Screens located in pits more than 4 feet (1.2 m) deep must be provided with stairway access. Access ladders are acceptable for pits less than 4 feet (1.2 m) deep, in lieu of stairways. Screening devices, installed in a building where other equipment or offices are located, must be isolated from the rest of the building, be provided with separate outside entrances, and be provided with separate and independent fresh air supply.

Fresh air must be forced into enclosed screening device areas or into open pits more than 4 feet deep (1.2 m). Dampers should not be used on exhaust or fresh air ducts and fine screens or other obstructions should be avoided to prevent clogging. Where continuous ventilation is required at least 12 complete air changes per hour must be provided. Where continuous ventilation would cause excessive heat loss, intermittent ventilation of at least 30 complete air changes per hour must be provided when workers enter the area.

Switches for operation of ventilation equipment should be marked and located conveniently. All intermittently operated ventilation equipment must be interconnected with the respective pit lighting system. The fan wheel should be fabricated from non-sparking material. Gas detectors must be provided in accordance with Section 57.

61.14 Safety and Shields

61.141 Railings and Gratings

Manually cleaned screen channels, must be protected by guard railings and deck gratings, with adequate provisions for removal or opening to facilitate raking.

Mechanically cleaned screen channels, must be protected by guard railings and deck gratings. Consideration should also be given to temporary access arrangements to facilitate maintenance and repair.

61.142 Mechanical Devices

Mechanical screening equipment must have adequate removal enclosures to protect personnel against accidental contact with moving parts and to prevent dripping in multi-level installations.

A positive means of locking out each mechanical device and temporary access for use during maintenance must be provided.

61.143 Drainage

Floor design and drainage must be provided to prevent slippery areas.

61.144 Lighting

Suitable lighting must be provided in all work and access areas. Refer to Section 61.152.

61.15 Control Systems

61.151 Timing Devices

All mechanical units that are operated by timing devices must be provided with auxiliary controls that will set the cleaning mechanism in operation at a preset high water elevation. If the cleaning mechanism fails to lower the high water, a warning should be signaled.

61.152 Electrical Fixtures and Controls

Electrical fixtures and controls in the screening area where hazardous gases may accumulate must meet the requirements of the National Electrical Code for Class I, Group D, Division 1, locations.

61.153 Manual Override

Automatic controls must be supplemented by a manual override.

61.2 Fine Screens

61.21 General

Fine screens as discussed here have openings of approximately 1/16 inch (1.6 mm). The amount of material removed by fine screens is dependent on the waste stream being treated and screen opening size. Fine screens may require close operational attention to function properly.

Fine screens should not be considered equivalent to primary sedimentation but may be considered for use in lieu of primary sedimentation where subsequent treatment units are designed on the basis of anticipated screen performance. Selection of screen capacity should consider flow restriction due to retained solids, gummy materials, frequency of cleaning, and extent of cleaning. Where fine screens are used, additional provision for removal of floatable oils and greases must be considered.

61.22 Design

Tests should be conducted to determine BOD_5 and suspended solids removal efficiencies at the design maximum day flow and design maximum day BOD_5 loadings. Pilot testing for an extended time is preferred.

A minimum of two fine screens must be provided, each unit being capable of independent operation. Capacity must be provided to treat design peak instantaneous flow with one unit out of service.
Fine screens must be preceded by a coarse bar screening device. Fine screens must be protected from freezing and located to facilitate maintenance.

61.23 Electrical Fixtures and Control

Electrical fixtures and controls in the screening area where hazardous gases may accumulate must meet the requirements of the National Electrical Code for Class I, Group D, Division 1, locations.

61.24 Servicing

Hosing equipment must be provided to facilitate cleaning. Provision must be made for isolating and removing units from their location for servicing.

62. COMMINUTORS

62.1 General

Provisions for access, ventilation, shields, and safety must conform to Sections 61.13, 61.14, and 61.15.

62.2 When Used

Comminutors may be used in lieu of screening devices to protect equipment where stringy substance accumulation on downstream equipment will not be a substantial problem.

62.3 Design Considerations

62.31 Location

Comminutors should be located downstream of any grit removal equipment and be protected by a coarse screening device. Comminutors not proceeded by grit removal equipment must be protected by a 6.0 inch (152 mm) deep gravel trap.

62.32 Size

Comminutor capacity must be adequate to handle design peak hourly flow.

62.33 Installation

A screened bypass channel must be provided. The use of the bypass channel should be automatic for all comminutor failures.

Gates must be provided in accordance with Sections 61.123 and 61.124.

62.34 Servicing

Provision must be made to facilitate servicing units in place and removing units from their location for servicing.

62.35 Electrical Controls and Motors

Electrical equipment in comminutor chambers where hazardous gases may accumulate must meet the requirements of the National Electrical Code for Class I, Group D, Division 1, locations. Motors must be protected against accidental submergence.

63. GRIT REMOVAL FACILITIES

63.1 When Required

Grit removal facilities are required for all mechanical wastewater treatment plants, and are required for plants receiving wastewater from combined sewers or from sewer systems receiving substantial amounts of grit. If a plant serving a separate sewer system is designed without grit removal facilities, the design must include provision for future installation. Consideration must be given to possible damaging effects on pumps, comminutors, and other preceding equipment, and the need for additional storage capacity in treatment units where grit is likely to accumulate.

63.2 Location

63.21 General

Grit removal facilities should be located ahead of pumps and comminuting devices. Coarse bar racks should be placed ahead of grit removal facilities.

63.22 Housed Facilities

63.221 Ventilation

Uncontaminated air must be introduced continuously at a rate of 12 air changes per hour, or intermittently at a rate of 30 air changes per hour. Odor control facilities may also be warranted.

63.222 Access

Adequate stairway access to above or below grade facilities must be provided.

63.223 Electrical

All electrical work in enclosed grit removal areas where hazardous gases may accumulate must meet the requirements of the National Electrical Code of Class I, Group D, Division 1, locations. Explosion-proof gas detectors must be provided in accordance with Section 57.

63.23 Outside Facilities

Grit removal facilities located outdoors must be protected from freezing.

63.3 Type and Number of Units

Plants treating wastes from combined sewers should have at least two mechanically cleaned grit removal units, with provisions for bypassing. A single manually cleaned or mechanically cleaned grit chamber with bypass is acceptable for small wastewater treatment plants serving separate sanitary sewer systems. Minimum facilities for larger plants serving separate sanitary sewers should be at least one mechanically cleaned unit with a bypass.

Facilities other than channel-type must be provided with adequate and flexible controls for velocity and/or air supply devices and with grit collection and removal equipment. Aerated grit chambers should have air rates adjustable in the range of 3 to 8 cubic feet per minute per foot (0.3 to 0.7 m^3/m) of tank length. Detention time in the tank should be in the range of 3 to 5 minutes at design peak hourly flows.

63.4 Design Factors

63.41 General

The design effectiveness of a grit removal system must be commensurate with the requirements of the subsequent process units.

63.42 Inlet

Inlet turbulence must be minimized in channel type units.

63.43 Velocity and Detention

Channel-type chambers must be designed to control velocities during normal variations in flow as close as possible to one foot per second (0.30 m/s). The detention period must be based on the size of particle to be removed. All aerated grit removal facilities should be provided with adequate control devices to regulate air supply and agitation.

63.44 Grit Washing

The need for grit washing should be determined by the method of final grit disposal.

63.45 Dewatering

Provision must be made for isolating and dewatering each unit. The design must provide for complete draining and cleaning by means of a sloped bottom equipped with a drain sump.

63.46 Water

An adequate supply of water under pressure must be provided for cleanup.

63.47 Grit Handling

Grit removal facilities located in deep pits should be provided with mechanical equipment for hoisting or transporting grit to ground level. Impervious, non-slip, working surfaces with adequate drainage must be provided for grit handling areas. Grit transporting facilities must be provided with protection against freezing and loss of material.

64. PREAERATION

Preaeration of wastewater to reduce septicity may be required in special cases.

65. FLOW EQUALIZATION

65.1 General

Use of flow equalization should be considered where significant variations in organic and hydraulic loadings can be expected.

65.2 Location

Equalization basins should be located downstream of pretreatment facilities such as bar screens, comminutors, and grit chambers.

65.3 Type

Flow equalization can be provided by using separate basins or on-line treatment units, such as aeration tanks. Equalization basins may be designed as either in-line or side-line units. Unused treatment units, such as sedimentation or aeration tanks, may be utilized as equalization basins during the early period of design life.

65.4 Size

Equalization basin capacity should be sufficient to effectively reduce expected flow and load variations to the extent deemed to be economically advantageous. With a diurnal flow pattern, the volume required to achieve the desired degree of equalization can be determined from a cumulative flow plot over a representative 24-hour period.

65.5 Operation

65.51 Mixing

Aeration or mechanical equipment must be provided to maintain adequate mixing. Corner fillets and hopper bottoms with draw-offs should be provided to alleviate the accumulation of sludge and grit.

65.52 Aeration

Aeration equipment must be sufficient to maintain a minimum of 1.0 mg/L of dissolved oxygen in the mixed basin contents at all times. Air supply rates should be a minimum of 1.25 cfm/1000 gallons (0.15 L/s/m^3) of storage capacity. The air supply should be isolated from other treatment plant aeration requirements to facilitate process aeration control, although process air supply equipment may be utilized as a source of standby aeration.

65.53 Controls

Inlets and outlets for all basin compartments must be suitably equipped with accessible external valves, stop plates, weirs, or other devices to permit flow control and the removal of an individual unit from service. Facilities must also be provided to measure and indicate liquid levels and flow rates.

65.6 Electrical

All electrical work in housed equalization basins must meet the requirements of the National Electrical Code for Class I, Group D, Division 1, locations.

65.7 Access

Suitable access must be provided to facilitate cleaning and the maintenance of equipment.

CHAPTER 70
SETTLING

71. GENERAL

71.1 Number of Units

Multiple units capable of independent operation are desirable and must be provided in all plants where design average flows exceed 100,000 gallons/day (379 m^3/d). Plants not having multiple units must include other provisions to assure continuity of treatment.

71.2 Flow Distribution

Effective flow splitting devices and control appurtenances (i.e., gates, splitter boxes, etc.) must be provided to permit proper proportioning of flow to each unit, throughout the expected range of flows.

72. DESIGN CONSIDERATIONS

72.1 Dimensions

The minimum length of flow from inlet to outlet is 10 feet (3 m) unless special provisions are made to prevent short-circuiting. The vertical side water depths must be designed to provide an adequate separation zone between the sludge blanket and the overflow weirs. The side water depths may not be less than the following values:

Type of Settling Tank	Minimum Side Water Depth ft.	(m)
Primary	7	2.1
Secondary tank following activated sludge process*	12	3.7
Secondary tank following fixed film reactor	10	3.0

* Greater side water depths are recommended for secondary clarifiers in excess of 4,000 square feet (372 m^2) surface area (equivalent to 70 feet (21 m) diameter) and for nitrification plants. Less than 12 feet (3.7 m) side water depths may be permitted for package plants with a design average flow less than 25,000 gallons per day (95 m^3/d), if justified based on successful operating experience.

72.2 Surface Overflow Rates

72.21 Primary Settling Tanks

Primary settling tank sizing should reflect the degree of solids removal needed and the need to avoid septic conditions during low flow periods. Sizing must be calculated for both design average and design peak hourly flow conditions, and the larger surface area determined must be used. The following surface overflow rates should not be exceeded in the design:

Surface Overflow Rates* at:

0004175

Tank Type	Design Avg. Flow gpd/ft^2 (L/s/m^2)	Design Peak Hourly Flow gpd/ft^2 (L/s/m^2)
Tanks not receiving waste activated sludge **	1,000 (0.47)	1,500 – 3,000 (0.71 – 1.42)
Tanks receiving waste activated sludge		1,000 (0.47)

* Surface overflow rates must be calculated with all flows received at the settling tanks. Primary settling of normal domestic sewage can be expected to removed approximately 1/3 of the influent BOD when operating at an overflow rate of 1000 gallons/day/ft^2 (0.47 L/s/m^2).

** Anticipated BOD removal should be determined by laboratory tests and consideration of the character of the wastes. Significant reduction in BOD removal efficiency will result when the peak hourly overflow rate exceeds 1500 gallons/day/ft^2 (0.71 L/s/m^2).

72.22 Final Settling Tanks

Settling tests must be conducted wherever a pilot study of biological treatment is warranted by unusual waste characteristics, treatment requirements, or where proposed loadings go beyond the limits set forth in this Section.

72.221 Final Settling Tanks - Fixed Film Biological Reactors

Surface overflow rates for settling tanks following trickling filters may not exceed 1,200 gallons per day per square foot (0.56 L/s/m^2 d) based on design peak hourly flow.

72.222 Final Settling Tanks - Activated Sludge

To perform properly while producing a concentrated return flow, activated sludge settling tanks must be designed to meet thickening as well as solids separation requirements. Since the rate of recirculation of return sludge from the final settling tanks to the aeration or reaeration tanks is quite high in activated sludge processes, surface overflow rate and weir overflow rate should be adjusted for the various processes to minimize the problems with sludge loadings, density currents, inlet hydraulic turbulence, and occasional poor sludge settleability. The size of the settling tank must be based on the larger surface area determined for surface overflow rate and solids loading rate. The following design criteria must be used:

Treatment Process	Surface Overflow Rate at Design Peak Hourly Flow* gallons/day/ft^2 (L/s/m^2)	Peak Solids Loading Rate*** lb/day/ft^2(kg/d/m^2)
Conventional, Step Aeration, Complete Mix Contact Stabilization, Carbonaceous Stage of Separate Stage Nitrification	1,200** (0.56)	50 (245)
Extended Aeration Single Stage Nitrification	1,000 (0.47)	35 (171)
2 Stage Nitrification	800 (0.38)	35 (171)
Activated Sludge with Chemical Addition to Mixed Liquor for Phosphorus Removal	900**** (37)	As Above

* Based on influent flow only.

** Plants needing to meet 20 mg/l suspended solids should reduce surface overflow rate to 1,000 gallons per day per square foot (0.47 L/s/m^2).

*** Clarifier peak solids loading rate must be computed based on the design maximum day flow rate plus the design maximum return sludge rate requirement and the design MLSS under aeration.

**** When phosphorus removal to a concentration of less than 1.0mg/l is required.

72.3 Inlet Structures

Inlets should be designed to dissipate the inlet velocity, to distribute the flow equally both horizontally and vertically and to prevent short-circuiting. Channels must be designed to maintain a velocity of at least one foot per second (0.3 m/s) at one-half of the design average flow. Corner pockets and dead ends must be eliminated and corner fillets or channeling must be used where necessary. Provisions must be made for elimination or removal of floating materials in inlet structures.

72.4 Weirs

72.41 General

Overflow weirs must be readily adjustable over the life of the structure to correct for differential settlement of the tank. Launders and weirs must be accessible for cleaning.

72.42 Location

Overflow weirs must be located to optimize actual hydraulic detention time, and minimize short-circuiting. Peripheral weirs must be placed at least one foot from the wall.

72.43 Design Rates

Weir loadings should not exceed:

Average Plant Capacity	Loading Rate at Design Peak Hourly Flow - gallons/day/ft (L/s/m)
Equal or less than 1 MGD (3785 m^3/d)	20,000 (2.9)
Greater than 1 MGD (3785 m^3/d)	30,000 (4.3)

If pumping is required, the pumps must be operated as continuously as possible. Also, weir loadings should be related to pump delivery rates to avoid short-circuiting.

72.44 Weir Troughs

Weir troughs must be designed to prevent submergence at design peak hourly flow, and to maintain a velocity of at least one foot per second (0.3 m/s) at one-half design average flow. Submerged weirs may be allowed for biological nutrient removal facilities to minimize the introduction of oxygen.

72.5 Submerged Surfaces

The tops of troughs, beams, and similar submerged construction elements must have a slope of at least 1.4 vertical to 1 horizontal; the underside of these elements must have a slope of 1 to 1 to prevent the accumulation of scum and solids.

72.6 Unit Dewatering

Unit dewatering features must conform to the provisions outlined in Section 54.3. The bypass design must also provide for distribution of the plant flow to the remaining units.

72.7 Freeboard

Walls of settling tanks must extend at least 6 inches (152 mm) above the surrounding ground surface and must provide at least 12 inches (304 mm) freeboard. Additional freeboard or the use of wind screens is recommended where larger settling tanks are subject to high velocity wind currents that would cause tank surface waves and inhibit effective scum removal.

73. SLUDGE AND SCUM REMOVAL

73.1 Scum Removal

Full surface mechanical scum collection and removal facilities, including baffling, must be provided for all settling tanks. The unusual characteristics of scum that may adversely affect pumping, piping, sludge handling and disposal, must be considered in design. Provisions may be made for the discharge of scum with the sludge; however, other special provisions for disposal may be necessary.

73.2 Sludge Removal

Mechanical sludge collection and withdrawal facilities must be designed to assure rapid removal of the sludge. Suction withdrawal should be provided for activated sludge plants designed for reduction of the nitrogenous oxygen demand and is recommended for those plants designed for carbonaceous oxygen demand reduction.

Each settling tank must have its own sludge withdrawal lines to insure adequate control of sludge wasting rate for each tank.

73.21 Sludge Hopper

The minimum slope of the side walls must be 1.7 vertical to 1 horizontal. Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal. Hopper bottoms may not have a maximum dimension of greater than 2 feet (610 mm). Extra depth sludge hoppers for sludge thickening are not acceptable.

73.22 Cross Collectors

Cross collectors serving one or more settling tanks may be useful in place of multiple sludge hoppers.

73.23 Sludge Removal Piping

Each hopper must have an individually valved sludge withdrawal line at least six inches (152 mm) in diameter. The static head available for withdrawal of sludge must be 30 inches (762 mm) or greater, as necessary to maintain a three foot per second (0.91 m/s) velocity in the withdrawal pipe. Clearance between the end of the withdrawal line and the hopper walls must be sufficient to prevent "bridging" of the sludge. Adequate provisions must be made for rodding or back-flushing individual pipe runs. Provisions must be made to allow for visual confirmation of return sludge. Piping must be provided to return sludge for further processing.

73.24 Sludge Removal Control

Separate settling tank sludge lines may drain to a common sludge well.

Sludge wells equipped with telescoping valves or other appropriate equipment must be provided for viewing, sampling, and controlling the rate of sludge withdrawal. A means of controlling and measuring the sludge removal rate must be provided for each clarifier. Air-lift type of sludge removal will not be approved for removal of primary sludges.

74. PROTECTIVE AND SERVICE FACILITIES

74.1 Operator Protection

All settling tanks must be equipped to enhance safety for operators. Such features must include machinery covers, life lines, stairways, walkways, handrails, and slip-resistant surfaces, where appropriate.

74.2 Mechanical Maintenance Access

The design must provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanisms, baffles, weirs, inlet stilling baffle areas, and effluent channels.

74.3 Electrical Fixtures and Controls

Electrical fixtures and controls in enclosed settling basins must meet the requirements of the National Electrical Code for Class I, Group D, Division 1, locations, with the exception of secondary clarifiers following extended aeration activated sludge treatment plants. Unless hazardous gasses are known to be present, enclosed secondary clarifiers following extended aeration processes are not classified as an explosive environment. In all cases, adequate ventilation must be provided.

The fixtures and controls must be located so as to provide convenient and safe access for operation and maintenance. Adequate area lighting must be provided.

74.4 Covering

Covering of secondary clarifiers for extended aeration facilities must be considered to prevent freezing of the water surface. Covers must be designed to facilitate all necessary maintenance. Adequate ventilation and corrosion control must be provided for enclosed tanks.

CHAPTER 80
SLUDGE PROCESSING, STORAGE, AND DISPOSAL

81. GENERAL

Facilities for processing sludge must be provided at all mechanical wastewater treatment plants. Handling equipment must be capable of processing sludge to a form suitable for ultimate disposal unless provisions acceptable to the regulatory agency are made for processing the sludge at an alternate location.

82. PROCESS SELECTION

The selection of sludge handling unit processes should be based upon at least the following considerations:

a. Local land use;

b. System energy requirements;

c. Cost effectiveness of sludge thickening and dewatering;

d. Equipment complexity and staffing requirements;

e. Adverse effects of heavy metals and other sludge components upon the unit processes;

f. Sludge digestion or stabilization requirements;

g. Sidestream or return flow treatment requirements (e.g., digester or sludge storage facilities supernatant, dewatering unit filtrate, wet oxidation return flows);

h. Sludge storage requirements;

i. Methods of ultimate disposal emphasizing beneficial use indicating compliance with local, state and federal sludge disposal regulations; and

j. Back-up techniques of sludge handling and disposal.

83. SLUDGE THICKENERS

83.1 Design Considerations

Sludge thickeners to reduce the volume of sludge should be considered. The design of thickeners (gravity, dissolved-air flotation, centrifuge, and others) should consider the type and concentration of sludge, the sludge stabilization processes, storage requirements, the method of ultimate sludge disposal, chemical needs, and the cost of operation. The use of gravity thickening tanks for unstabilized sludges is not recommended because of problems due to septicity unless provisions are made for adequate control of process operational problems and odors at the gravity thickener and any following unit processes.

Particular attention should be given to the pumping and piping of the concentrated sludge and possible onset of anaerobic conditions.

83.2 Prototype Studies

Process selection and unit process design parameters should be based on prototype studies. The regulatory agency will require such studies where the sizing of other plant units is dependent on performance of the thickeners. Refer to Section 53.2 for any new process determination.

84. ANAEROBIC SLUDGE DIGESTION

84.1 General

84.11 Multiple Units

Multiple units or alternate methods of sludge processing must be provided. Facilities for sludge storage and supernatant separation in an additional unit may be required, depending on raw sludge concentration and disposal methods for sludge and supernatant.

84.12 Depth

If process design provides for supernatant withdrawal, the proportion of depth to diameter should be such as to allow for the formation of a reasonable depth of supernatant liquor. A minimum side water depth of 20 feet (6.1 m) is recommended.

84.13 Design Maintenance Provisions

To facilitate emptying, cleaning and maintenance, the following features are desirable:

84.131 Slope

The tank bottom must slope to drain toward the withdrawal pipe. For tanks equipped with a suction mechanism for sludge withdrawal, a bottom slope not less than 1 to 12 is recommended. Where the sludge is to be removed by gravity alone, 1 to 4 slope is recommended.

84.132 Access Manholes

At least 2 access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes.

A separate side wall manhole must be provided that is large enough to permit the use of mechanical equipment to remove grit and sand. The side wall access manhole should be low enough to facilitate heavy equipment handling and may be buried in the earthen bank insulation.

83.133 Safety

Non-sparking tools, rubber-soled shoes, safety harness, gas detectors for flammable and toxic gases, and at least two self-contained breathing units must be provided for emergency use. Refer to other safety items as appropriate in Section 57.

84.14 Toxic Materials

If the anaerobic digestion process is proposed, the basis of design must be supported by wastewater analyses to determine the presence of undesirable materials, such as high concentrations of sulfates and inhibitory concentrations of heavy metals.

84.2 Sludge Inlets, Outlets, Recirculation, and High Level Overflow

84.21 Multiple Inlets and Draw-Offs

Multiple sludge inlets and draw-offs and, where used, multiple recirculation suction and discharge points to facilitate flexible operation and effective mixing of the digester contents, must be provided unless adequate mixing facilities are provided within the digester.

84.22 Inlet Configurations

One inlet should discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. The second inlet should be opposite to the suction line at approximately the 2/3 diameter point across the digester.

84.23 Inlet Discharge Location

Raw sludge inlet discharge points should be so located as to minimize short circuiting to the digest sludge or supernatant draw-offs.

84.24 Sludge Withdrawal

Sludge withdrawal to disposal should be from the bottom of the tank. The bottom withdrawal pipe should be interconnected with the necessary valving to the recirculation piping, to increase operational flexibility in mixing the tank contents.

84.25 Emergency Overflow

An unvalved vented overflow must be provided to prevent damage to the digestion tank and cover in case of accidental overfilling. This emergency overflow must be piped to an appropriate point and at an appropriate rate in the treatment process or sidestream treatment facilities to minimize the impact on process units.

84.3 Tank Capacity

84.31 Rational Design

The total digestion tank capacity must be determined based upon such factors as volume of sludge added, percent solids, and character, the temperature to be maintained in the digesters, the degree or extent of mixing to be obtained, the degree of volatile solids reduction required, method of sludge disposal, and the size of the installation with appropriate allowances for gas, scum, supernatant, and digested sludge storage. Secondary digesters of two-stage series digestion systems that are utilized for digested sludge storage and concentration may not be credited in the calculations for volumes required for sludge digestion. Calculations should be submitted to justify the basis of design with consideration given to ultimate disposal of sludge.

84.32 Standard Design

When such calculations are not submitted to justify the design based on the above factors, the minimum digestion tank capacity outlined below will be required. Such requirements assume that the raw sludge is derived from ordinary domestic wastewater, a digestion temperature is to be maintained in the range of 85 to 95 F (29 C to 35 C), 40 to 50 percent volatile matter in the digested sludge, and that the digested sludge will be removed frequently from the process (See also Sections 84.11 and 89.11.)

84.321 Completely Mixed Systems

For digestion systems providing for intimate and effective mixing of the digester contents, the system may be loaded up to 80 pounds of volatile solids per 1000 cubic feet (1.3 kg/m^3) of volume per day in the active digestion units.

84.322 Moderately Mixed Systems

For digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded up to 40 pounds of volatile solids per 1000 cubic feet of volume per day (0.65 kg/m^3) in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided.

84.323 Multistage Systems

For digestion systems utilizing two stages (primary and secondary units), the first stage (primary) may be either completely mixed or moderately mixed and loaded in accordance with Sections 84.321 or 84.322. The second stage (secondary) is to be designed for sludge storage, concentration, and gas collection and may not be credited in the calculations for volumes required for sludge digestion.

84.324 Digester Mixing

Facilities for mixing the digester contents must be provided where required for proper digestion by reason of loading rates or other features of the system. Where sludge recirculation pumps are used for mixing they must be provided in accordance with appropriate requirements of Section 87.1.

84.4 Gas Collection, Piping and Appurtenances

84.41 General

All portions of the gas system including the space above the tank liquor, storage facilities, and piping must be designed so that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under pressure. All enclosed areas where any gas leakage might occur must be adequately ventilated.

84.42 Safety Equipment

All necessary safety facilities must be included where gas is produced. Pressure and vacuum relief valves and flame trap, together with automatic safety shut off valves must be provided and protected from freezing. Water seal equipment may not be installed. Safety equipment and gas compressors should be housed in a separate room with an exterior door.

84.43 Gas Piping and Condensate

Gas piping must have a diameter of at least 4 inches (102 mm). A smaller diameter pipe at the gas production meter is acceptable. Gas piping must slope to condensation traps at low points. The use of float-controlled condensate traps is not permitted. Condensation traps must be protected from freezing.

Tightly fitted self-closing doors should be provided at connecting passageways and tunnels, which connect digestion facilities to other facilities to minimize the spread of gas. Piping galleries must be ventilated in accordance with Section 84.47.

84.44 Gas Utilization Equipment

Gas burning boilers, engines, etc., must be located in well-ventilated rooms. Such rooms would not ordinarily be classified as a hazardous location if isolated from the digestion gallery or ventilated in accordance with Section 84.47. Gas lines to these units must be provided with suitable flame traps.

84.45 Electrical Fixtures

Electrical fixtures and controls, in places enclosing anaerobic digestion appurtenances, where hazardous gases are normally contained in the tanks and piping, must comply with the National Electrical Code for Class I, Group D, Division 2, locations. Refer to Section 84.47.

84.46 Waste Gas

84.461 Location

Waste gas burners must be readily accessible and should be located at least 50 feet (15.2 m) away from any plant structure. Waste gas burners must be of sufficient height and so located to prevent injury to personnel due to wind or downdraft conditions.

84.462 Pilot Light

All waste gas burners must be equipped with automatic ignition such as a pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to insure reliability of the pilot.

84.463 Gas Piping Slope

Gas piping must be sloped at a minimum of 2 percent up to the waste gas burner with a condensate trap provided in a location not subject to freezing.

84.47 Ventilation

Any underground enclosures connecting with digestion tanks or containing sludge or gas piping or equipment must be provided with forced ventilation for dry wells in accordance with Sections 42.71 through 42.74 and 42.76.

84.48 Meter

A gas meter with bypass must be provided, to meter total gas production for each active digestion unit. Total gas production for two-stage digestion systems operated in series may be measured by a single gas meter with proper interconnected gas piping.

Where multiple primary digestion units are utilized with a single secondary digestion unit, a gas meter must be provided for each primary digestion unit. The secondary digestion unit may be interconnected with the gas measurement unit of one of the primary units. Interconnected gas piping must be properly valved with gas tight gate valves to allow measurement of gas production from either digestion unit or maintenance of either digestion unit.

Gas meters may be of the orifice plate, turbine, or vortex type. Positive displacement meters should not be utilized. The meter must be specifically designed for contact with corrosive and dirty gases.

84.5 Digestion Tank Heating

84.51 Insulation

Wherever possible digestion tanks should be constructed above ground-water level and must be suitably insulated to minimize heat loss. Maximum utilization of earthen bank insulation should be used.

84.52 Heating Facilities

Sludge may be heated by circulating the sludge through external heaters or by units located inside the digestion tank. Refer to Section 84.522.

84.521 External Heating

Piping must be designed to provide for the preheating of feed sludge before introduction into the digesters. Provisions must be made in the layout of the piping and valving to facilitate heat exchanger tube removal and cleaning of the lines. Heat exchanger sludge piping should be sized for peak heat transfer requirements. Heat exchangers should have a heating capacity of 130 percent of the calculated peak heating requirement to account for the occurrence of sludge tube fouling.

84.522 Other Heating Methods

a. The use of hot water heating coils affixed to the walls of the digester, or other types of internal heating equipment that require emptying the digester contents for repair, are not acceptable.

b. Other systems and devices have been developed recently to provide both mixing and heating of anaerobic digester contents. These systems will be reviewed on their own merits. Operating data detailing their reliability, operation, and maintenance characteristics will be required. Refer to Section 53.2.

84.53 Heating Capacity

84.531 Capacity

Sufficient heating capacity must be provided to consistently maintain the design sludge temperature considering insulation provisions and ambient cold weather conditions. Where digester tank gas is used for other purposes, an auxiliary fuel may be required.

84.532 Standby Requirements

The provision of standby heating capacity or the use of multiple units sized to provide the heating requirements must be considered unless acceptable alternative means of handling raw sludge are provided for the extended period that digestion process outage is experienced due to heat loss.

84.54 Hot Water Internal Heating Co ntrols

84.541 Mixing Valves

A suitable automatic mixing valve must be provided to temper the boiler water with return water so that the inlet water to the removable heat jacket or coil in the digester can be held below a temperature at which caking will be accentuated. Manual control should also be provided by suitable bypass valves.

84.542 Boiler Controls

The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 180° F (82° C) to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, low gas pressure, or excessive boiler water temperature or pressure.

84.543 Boiler Water Pumps

Boiler water pumps must be sealed and sized to meet the operating conditions of temperature, operating head, and flow rate. Duplicate units must be provided.

84.544 Thermometers

Thermometers must be provided to show inlet and outlet temperatures of the sludge, hot water feed, hot water return, and boiler water.

84.545 Water Supply

The chemical quality should be checked for suitability for this use. Refer to Section 56.23 for required break tank for indirect water supply connections.

84.55 External Heater Operating Controls

All controls necessary to insure effective and safe operation are required. Provision for duplicate units in critical elements should be considered.

84.6 Supernatant Withdrawal

Where supernatant separation is to be used to concentrate sludge in the digester units and increase digester solids retention time, the design must provide for ease of operation and positive control of supernatant quality.

84.61 Piping Size

Supernatant piping should not be less than 6 inches (152 mm) in diameter.

84.62 Withdrawal Arrangements

84.621 Withdrawal Levels

Piping should be arranged so that withdrawal can be made from 3 or more levels in the tank. An unvalved vented overflow must be provided. The emergency overflow must be piped to an appropriate point and at an appropriate rate in the treatment process or side stream treatment units to minimize the impact on process units.

84.622 Withdrawal Selection

On fixed cover tanks the supernatant withdrawal level should preferably be selected by means of interchangeable extensions at the discharge end of the piping.

84.623 Supernatant Selector

A fixed screen supernatant selector or similar type device may be used only in an unmixed secondary digestion unit. If such supernatant selector is provided, provisions must be made for at least one other draw-off level located in the supernatant zone of the tank, in addition to the unvalved emergency supernatant draw-off pipe. High pressure back-wash facilities must be provided.

84.63 Sampling

Provisions must be made for sampling at each supernatant draw-off level. Sampling pipes should be at least 1 1/2 inches (38 mm) in diameter and should terminate at a suitably sized sampling sink or basin.

84.64 Supernatant Disposal

Supernatant return and disposal facilities should be designed to alleviate adverse hydraulic and organic effects on plant operations. If nutrient removal (e.g., phosphorus, ammonia) must be accomplished at a plant, then a separate supernatant side stream treatment system should be provided.

85. AEROBIC SLUDGE DIGESTION

85.1 General

The aerobic sludge digestion system must include provisions for digestion, supernatant separation, sludge concentration, and any necessary sludge storage. These provisions may be accomplished by separate tanks or processes, or in the digestion tanks.

85.2 Multiple Units

Multiple digestion units capable of independent operation are desirable and must be provided in all plants where the design average flow exceeds 100,000 gallons per day (379 m^3/d). All plants not having multiple units must provide alternate sludge handling and disposal methods.

85.3 Tank Capacity

85.31 Volume Required

The following digestion tank capacities are based on a solids concentration of 2 percent with supernatant separation performed in a separate tank. If supernatant separation is performed in the digestion tank, a minimum of 25 percent additional volume is required. These capacities must be provided unless sludge thickening facilities (refer to Section 83) are utilized to thicken the feed solids concentration to greater than 2 percent. If such thickening is provided, the digestion volumes may be decreased proportionally.

Sludge Source	Volume/Pop. (ft^3/P.E.)	Equiv.(P.E.) (M^3/P.E.)
Waste activated sludge -- no primary settling	4.5*	(0.13)
Primary plus waste activated sludge	4.0*	(0.11)
Waste activated sludge exclusive of primary sludge	2.0*	(0.06)
Extended aeration activated sludge	3.0	(0.09)
Primary plus fixed film reactor sludge	3.0	(0.09)

* These volumes also apply to waste activated sludge from single stage nitrification facilities with less than 24 hours detention time based on design average flow.

85.32 Effect of Temperature on Volume

The volumes in Section 85.31 are based on digester temperatures of 59° F (15° C) and a solids retention time of 27 days. Aerobic digesters must be covered to minimize heat loss or these volumes must be increased for colder temperature applications. Refer to Section 85.8 for necessary sludge storage. Additional volume may be required if the land application disposal method is used in order to meet applicable federal regulatory requirements.

85.4 Mixing

Aerobic digesters must be provided with mixing equipment that can maintain solids in suspension and insure complete mixing of the digester contents. Refer to Section 85.5.

85.5 Air Requirements

Sufficient air must be provided to keep the solids in suspension and maintain dissolved oxygen between 1 and 2 milligrams per liter (mg/l). For minimum mixing and oxygen requirements, an air supply of 30 cfm per 1000 cubic feet (0.5 L/s/m^3) of tank volume must be provided with the largest blower out of service. If diffusers are used, the nonclog type is recommended and they should be designed to permit continuity of service. If mechanical turbine aerators are utilized, at least two turbine aerators per tank must be provided to permit continuity of service. Mechanical aerators are not recommended for use in aerobic digesters where freezing conditions will cause ice build-up on the aerator and support structures.

85.6 Supernatant Separation and Scum and Grease Removal

85.61 Supernatant Separation

Facilities must be provided for effective separation or decanting of supernatant. Separate facilities are recommended; however, supernatant separation may be accomplished in the digestion tank provided additional volume is provided per Section 85.3. The supernatant draw-off unit must be designed to prevent recycle of scum and grease back to plant process units. Provisions should be made to withdraw supernatant from multiple levels of the supernatant withdrawal zone.

85.62 Scum and Grease Removal

Facilities must be provided for the effective collection of scum and grease from the aerobic digester for final disposal and to prevent its recycle back to the plant process and to prevent long term accumulation and potential discharge in the effluent.

85.7 High Level Emergency Overflow

An unvalved high level overflow and any necessary piping must be provided to return digester overflow back to the head of the plant or to the aeration process in case of accidental overfilling. Design considerations related to the digester overflow must include waste sludge rate and duration during the period the plant is unattended, potential effects on plant process units, discharge location of the emergency overflow, and potential discharge of suspended solids in the plant effluent.

85.8 Digested Sludge Storage Volume

85.81 Sludge Storage Volume

Sludge storage must be provided in accordance with Section 89 to accommodate daily sludge production volumes and as an operational buffer for unit outage and adverse weather conditions. Designs utilizing increased sludge age in the activated sludge system as a means of storage are not acceptable.

85.82 Liquid Sludge Storage

Liquid sludge storage facilities must be based on the following values unless digested sludge thickening facilities are utilized (refer to Section 83) to provide solids concentrations of greater than 2 percent.

Sludge Source	(ft^3/P.E.)	Volume (M^3/P.E.)
Waste activated sludge -- no primary settling, primary plus waste activated sludge, extended aeration activated sludge	0.13	(0.004)
Waste activated sludge -- exclusive of primary sludge	0.06	(0.002)
Primary plus fixed -- film reactor sludge	0.10	(0.003)

86. HIGH pH STABILIZATION

86.1 General

Alkaline material may be added to liquid primary or secondary sludges for sludge stabilization in lieu of digestion facilities; to supplement existing digestion facilities; or for interim sludge handling. There is no direct reduction of organic matter or sludge solids with the high pH stabilization process. There is an increase in the mass of dry sludge solids. Without supplemental dewatering, additional volumes of sludge will be generated. The design must account for the increased sludge quantities for storage, handling, transportation, and disposal methods and associated costs.

86.2 Operational Criteria

Sufficient alkaline material must be added to liquid sludge to produce a homogeneous mixture with a minimum pH of 12 after 2 hours of vigorous mixing without further alkali addition. The pH of the sludge must remain above 11.5 for an additional 22 hours. Facilities for adding supplemental alkaline material must be provided to maintain the pH of the sludge during interim sludge storage periods.

86.3 Odor Control and Ventilation

Odor control facilities must be provided for sludge mixing and treated sludge storage tanks when located within 1/2 mile (0.8 km) of residential or commercial areas. The reviewing authority should be contacted for design and air pollution control objectives to be met for various types of air scrubber units. Ventilation is required for indoor sludge mixing, storage or processing facilities. See Section 42.71 through 42.74 and 42.76 for ventilation requirements.

86.4 Mixing Tanks and Equipment

86.41 Tanks

Mixing tanks may be designed to operate as either a batch or continuous flow process. A minimum of two tanks must be provided of adequate size to provide a minimum 2 hours contact time in each tank. The following items must also be considered in determining the number and size of tanks:

a. peak sludge flow rates;

b. storage between batches;

c. dewatering or thickening performed in tanks;

d. repeating sludge treatment due to pH decay of stored sludge;

e. sludge thickening prior to sludge treatment; and

f. type of mixing device used and associated maintenance or repair requirements.

86.42 Equipment

Mixing equipment must be designed to provide vigorous agitation within the mixing tank, maintain solids in suspension and provide for a homogeneous mixture of the sludge solids and alkaline material. Mixing may be accomplished either by diffused air or mechanical mixers. If diffused aeration is used, an air supply of 30 cfm per 1000 cubic feet ($0.5 L/s/m^3$) of mixing tank volume must be provided with the largest blower out of service. When diffusers are used, the nonclog type is recommended, and they should be designed to permit continuity of service. If mechanical mixers are used, the impellers must be designed to minimize fouling with debris in the sludge and consideration must be given to providing continuity of service during freezing weather conditions.

86.5 Chemical Feed and Storage Equipment

86.51 General

Alkaline material is caustic in nature and can cause eye and tissue injury. Equipment for handling or storing alkaline material must be designed for adequate operator safety. Refer to Section 57 for proper safety precautions. Storage, slaking, and feed equipment should be sealed as airtight as practical to prevent contact of alkaline materials with atmospheric carbon dioxide and water vapor and to prevent the escape of dust material. All equipment and associated transfer lines or piping must be accessible for cleaning.

86.52 Feed and Slaking Equipment

The design of the feeding equipment must be based on the treatment plant size, type of alkaline material used, slaking required, and operator requirements. Equipment may be either of batch or automated type. Automated feeders may be of the volumetric or gravimetric type depending on accuracy, reliability, and maintenance requirements. Manually operated batch slaking of quicklime (CaO) should be avoided unless adequate protective clothing and equipment are provided. At small plants, use of hydrated lime [$Ca(OH)2$] is recommended over quicklime due to safety and labor-saving reasons. Feed and slaking equipment must be sized to handle a minimum of 150% of the peak sludge flow rate including sludge that may need to be retreated due to pH decay. Duplicate units must be provided.

86.53 Chemical Storage Facilities

Alkaline materials may be delivered either in bag or bulk form depending upon the amount of material used. Material delivered in bags must be stored indoors and elevated above floor level. Bags should be of the multi-wall moisture-proof type. Dry bulk storage containers must be as airtight as practical and must contain a mechanical agitation mechanism. Storage facilities must be sized to provide a minimum of a 30-day supply.

86.6 Sludge Storage

Refer to Section 89 for general design considerations for sludge storage facilities. The design must incorporate the following considerations for the storage of high pH stabilized sludge:

86.61 Liquid sludge

Liquid high pH stabilized sludge may not be stored in a lagoon. This sludge must be stored in a tank or vessel equipped with rapid sludge withdrawal mechanisms for sludge disposal or retreatment. Provisions must be made for adding alkaline material in the storage tank. Mixing equipment in accordance with Section 86.42 above must also be provided in all storage tanks.

86.62 Dewatered Sludge

On-site storage of dewatered high pH stabilized sludge should be limited to 30 days. Provisions for rapid retreatment or disposal of dewatered sludge stored on-site must also be made in case of sludge pH decay.

86.63 Off-Site Storage

There may not be any off-site storage of high pH stabilized sludge unless specifically permitted by the regulatory agency.

86.7 Disposal

Immediate sludge disposal methods and options are recommended to be utilized in order to reduce the sludge inventory on the treatment plant site and amount of sludge that may need to be retreated to prevent odors if sludge pH decay occurs. If the land application option is utilized for high pH stabilized sludge, the sludge should be incorporated into the soil during the same day of delivery to the site and application must comply with applicable state and federal disposal regulations.

87. SLUDGE PUMPS AND PIPING

87.1 Sludge Pumps

87.11 Capacity

Pump capacities must be adequate but should not be excessive. Provision for varying pump capacity is desirable. A rational basis of design must be provided with the plan documents. Variability in sludge mass and volume must be considered in pump selection.

87.12 Duplicate Units

Duplicate units must be provided at all installations.

87.13 Type

Plunger pumps, screw feed pumps or other types of pumps with demonstrated solids handling capability must be provided for handling raw sludge. Where centrifugal pumps are used, a parallel positive displacement pump must be provided as an alternate to pump heavy sludge concentrations, such as primary or thickened sludge, that may exceed the pumping head of the centrifugal pump.

87.14 Minimum Head

A minimum positive head of 24 inches (610 mm) must be provided at the suction side of centrifugal type pumps and is desirable for all types of sludge pumps. Maximum suction lifts should not exceed 10 feet (3 m) for plunger pumps.

87.15 Sampling Facilities

Unless sludge sampling facilities are otherwise provided, quick-closing sampling valves must be installed at the sludge pumps. The size of valve and piping should be at least 1 1/2 inches (38 mm) and terminate at a suitably sized sampling sink or floor drain.

87.16 Safety

High pressure shut off switches and alarms must be used on positive displacement pumps to prevent dangerous conditions.

87.2 Sludge Piping

87.21 Size and Head

Digested sludge withdrawal piping should have a minimum diameter of 8 inches (203 mm) for gravity withdrawal and 6 inches (152 mm) for pump suction and discharge lines. Where withdrawal is by gravity, the available head on the discharge pipe should be at least 4 feet (1.2 m) and preferably more. Undigested sludge withdrawal piping must be sized in accordance with Section 73.23.

87.22 Slope and Flushing Requirements

Gravity piping should be laid on uniform grade and alignment. Slope on gravity discharge piping should not be less than 3 percent for primary sludges and all sludges thickened to greater than 2 percent solids. Slope on gravity discharge piping should not be less than 2 percent for aerobically digested sludge or waste activated sludge with less than 2 percent solids. Cleanouts must be provided for all gravity sludge piping. Provisions must be made for draining and flushing discharge lines. All sludge pipes must be suitably located or otherwise adequately protected to prevent freezing.

87.23 Supports

Special consideration should be given to the corrosion resistance and permanence of supporting systems for piping located inside the digestion tank.

88. SLUDGE DEWATERING

88.1 General

On-site sludge dewatering facilities must be provided for all plants, although the following requirements may be reduced, if justified, with on-site liquid sludge storage facilities or approved off-site sludge disposal.

88.11 Anaerobic Digestion Sludge Production

For calculating design sludge handling and disposal needs, sludge production values from a two-stage anaerobic digestion process must be based on a maximum solids concentration of 5 percent without additional thickening. The solids production values on a dry weight basis must be based on the following for the listed processes:

Primary plus waste activated sludge - at least 0.12 lbs./P.E./day (0.05 kg/P.E./d.).

Primary plus fixed film sludge - at least 0.09 lbs./P.E./day (0.04 kg/P.E./d.).

88.12 Aerobic Digestion Sludge Production

For calculating design sludge handling and disposal needs, sludge production values for aerobic digesters must be based on a maximum solids concentration of 2 percent without additional thickening. The solids production values on a dry weight basis must be based on the following for the listed processes:

Primary plus waste activated sludge - at least 0.16 lbs./P.E./day (0.07 kg/P.E./d.).

Primary plus fixed film sludge - at least 0.12 lbs./P.E./day (0.05 kg/P.E./d.).

88.13 Production From Other Sludge Stabilization Processes

For calculating design sludge handling and disposal needs for sludge stabilization processes other than those described in Sections 88.11 and 88.12, a rational basis of design for sludge production values must be developed and provided to the reviewing authority for approval on a case-by-case basis.

88.2 Sludge Drying Beds

86.21 Applicability

Sludge drying beds may be used for dewatering well digested sludge from either the anaerobic or aerobic process. Due to the large volume of sludge produced by the aerobic digestion process, consideration should be given to using a combination of dewatering systems or other means of ultimate sludge disposal.

88.22 Unit Sizing

Sludge drying bed area must be calculated on a rational basis with the following items considered:

a. The volume of wet sludge produced by existing and proposed processes.

b. Depth of wet sludge drawn to the drying beds. For design calculation purposes a maximum depth of 8 inches (203 mm) must be utilized. For operational purposes, the depth of sludge placed on the drying bed may increase or decrease from the design depth based on the percent solids content and type of digestion utilized.

c. Total digester volume and other wet sludge storage facilities.

d. Degree of sludge thickening provided after digestion.

e. The maximum drawing depth of sludge, which can be removed from the digester or other sludge storage facilities without causing process or structural problems.

f. The time required on the bed to produce a removable cake. Adequate provision must be made for sludge dewatering and/or sludge disposal facilities for those periods of time during which outside drying of sludge on beds is hindered by weather. Drying during the winter months should not be anticipated in sizing beds.

g. Capacities of auxiliary dewatering facilities.

88.23 Percolation Type Bed Components

88.231 Gravel

The lower course of gravel around the underdrains should be properly graded and should be 12 inches (305 mm) in depth, extending at least 6 inches (152 mm) above the top of the underdrains. It is desirable to place this in 2 or more layers. The top layer of at least 3 inches (76 mm) should consist of gravel 1/8 to 1/4 inch (3 to 6 mm) in size.

88.232 Sand

The top course should consist of 6 to 9 inches (152 to 229 mm) of clean, washed, course sand. The effective size of the sand should be in the range of 0.8 to 1.5 millimeter (mm). The finished sand surface should be level.

88.233 Underdrains

Underdrains should be at least 4 inches (102 mm) in diameter laid with open joints. Perforated pipe may also be used. Underdrains should be spaced not more than 20 feet (6.1 m) apart and sloped at a minimum of 1 percent. Lateral tiles should be spaced at 8 to 10 feet (2.4 to 3.0m). Various pipe materials may be selected provided the pipe is corrosion resistant and appropriately bedded to insure that the underdrains are not damaged by sludge removal equipment.

88.234 Additional Dewatering Provisions

Consideration must be given to providing a means of decanting supernatant of sludge placed on the sludge drying beds. More effective decanting of supernatant may be accomplished with polymer treatment of sludge.

88.235 Seal

The bottom must be sealed in a manner approved by the reviewing authority.

88.24 Walls

Walls should be water-tight and extend 18 inches (457 mm) above and at least 6 inches (152 mm) below the surface of the bed. Outer walls should be extended at least 4 inches (102 mm) above the outside grade elevation to prevent soil from washing on to the beds.

88.25 Sludge Removal

Each bed must be constructed so as to be readily and completely accessible to mechanical cleaning equipment. Concrete runways spaced to accommodate mechanical equipment must be provided. Special attention should be given to assure adequate access to the areas adjacent to the sidewalls. Entrance ramps down to the level of the sand bed must be provided. These ramps should be high enough to eliminate the need for an entrance end wall for the sludge bed.

88.3 Sludge Lagoons as Dewatering Units

88.31 General

Sludge lagoons as a means of dewatering digested sludge will be permitted only upon proof that the character of the digested sludge and the design mode of operation are such that offensive odors will not result. Where sludge lagoons are permitted, adequate provisions must be made for other sludge dewatering facilities or sludge disposal in the event of upset or failure of the sludge digestion process.

88.32 Location

Sludge lagoons must be located as far as practicable from inhabited areas or areas likely to be inhabited during the lifetime of the structures. Siting of sludge lagoons must comply with the requirements of the reviewing authority.

88.33 Seal

Adequate provisions must be made to seal the sludge lagoon bottoms and embankments in accordance with Section 93.422 to prevent leaching into adjacent soils or groundwater.

88.34 Access

Provisions must be made for pumping or heavy equipment access for sludge removal from the sludge lagoon.

88.4 Mechanical Dewatering Facilities

88.41 General

Provision must be made to maintain sufficient continuity of service so that sludge may be dewatered without accumulation beyond storage capacity. The number of vacuum filters, centrifuges, filter presses, belt filters, or other mechanical dewatering facilities should be sufficient to dewater the sludge produced with the largest unit out of service. Unless other standby wet sludge facilities are available, adequate storage facilities of at least 4 days production volume must be provided. Documentation must be submitted justifying the basis of design of mechanical dewatering facilities.

88.42 Auxiliary Facilities for Vacuum Filters

Back-up vacuum and filtrate pumps must be provided. It is permissible to have uninstalled back-up vacuum and filtrate pumps for every three or less vacuum filters, provided that the installed units can easily be removed and replaced. At least one filter media replacement unit must be provided.

88.43 Ventilation

Adequate facilities must be provided for ventilation of the dewatering area. The exhaust air should be properly conditioned to avoid odor nuisance. Ventilation must be provided in accordance with Section 42.7.

88.44 Chemical Handling Enclosures

Lime-mixing facilities should be completely enclosed to prevent the escape of lime dust. Chemical handling equipment should be automated to eliminate the manual lifting requirement. Refer to Section 57.

88.5 Drainage and Filtrate Disposal

Drainage from beds, lagoon supernatant and filtrate from dewatering units must be returned to the wastewater treatment process at appropriate points and rates.

88.6 Other Dewatering Facilities

If dewatering sludge is proposed by other methods, a detailed description of the process and design data must accompany the plans. Refer to Section 53.2 for any new process determinations.

89. SLUDGE STORAGE AND DISPOSAL

89.1 Storage

89.11 General

Sludge storage facilities must be provided at all mechanical treatment plants. Appropriate storage facilities may consist of any combination of drying beds, lagoons, separate tanks, additional volume in sludge stabilization units, pad areas or other means to store either liquid or dried sludge. Refer to Sections 88.2 and 88.3 for drying bed and lagoon design criteria respectively.

The design must provide for odor control in sludge storage tanks and sludge lagoons, including aeration, covering or other appropriate means.

89.12 Volume

Calculations justifying the number of days of storage to be provided must be submitted and must be based on the total sludge handling and disposal system. Refer to Section 88.1 for anaerobically and aerobically digested sludge production values. Sludge production values for other stabilization processes should be justified in the basis of design. If land application is the only means of sludge disposal utilized at a treatment plant, sludge storage provisions must be based on the following factors:

a. Inclement weather effects on access to the application land;

b. Temperatures including frozen ground and stored sludge cake conditions;

c. Haul road restrictions including spring thawing conditions;

d. Area seasonal rainfall patterns;

e. Cropping practices on available land, including nutrient requirements;

f. Potential for increased sludge volumes from industrial sources during the design life of the plant;

g. Available area for expanding sludge storage; and

h. Appropriate pathogen reduction and vector attraction reduction requirements.

A minimum of 180 days storage should be provided for the design life of the plant where land application is the only means of disposal, unless a different period is approved by the regulatory agency. Refer to Section 89.22 for other sludge land application considerations.

89.2 Disposal

89.21 Sanitary Landfilling

Sludge and sludge residues may be disposed of in approved sanitary landfills under the terms and conditions of the reviewing authority. Typically sludges must be dewatered and capable of passing a paint filter test to be suitable for disposal in an approved landfill.

89.22 Land Application

The beneficial use of sludge is encouraged in all cases. The Department should be contacted for specific design and approval requirements governing land application of municipal sludges. Additional operating criteria may be obtained from applicable federal regulations. Sludge may be utilized as a soil conditioner for agricultural, horticultural, or reclamation purposes. Important design considerations include but are not necessarily limited to: sludge stabilization process, sludge chemical make up, pathogen density, application site characteristics (soil, groundwater elevations, setback distance requirements, etc.), local topography and hydrology, cropping practices, spreading and incorporation techniques, population density and odor control, local groundwater quality and usage. In order to comply with the facility's effluent standards, alternative sludge disposal options are recommended for all treatment facilities due to inclement weather and cropping practices.

The Federal 40 CFR Part 503 Sludge Disposal regulations govern the application of sludge to land.

89.23 Sludge Lagoons for Disposal

The utilization of lagoons for ultimate disposal of sludge is not allowed.

89.24 Other Disposal Methods

If disposal of sludge by other methods is proposed, a detailed description of the technique and design data must accompany the plans. Refer to Section 53.2 for any new process determination.

CHAPTER 90
BIOLOGICAL TREATMENT

91. TRICKLING FILTERS

91.1 General

Trickling filters may be used for treatment of wastewater amenable to treatment by aerobic biologic process. Trickling filters must be preceded by effective settling tanks equipped with scum and grease collecting devices, or other suitable pretreatment facilities.

Filters must be designed to provide for reduction in carbonaceous and/or nitrogenous oxygen demand in accordance with water quality standards and objectives for the receiving waters as established by the reviewing agency, or to properly condition the wastewater for subsequent treatment processes. Multi-stage filters should be considered if needed to meet more stringent effluent standards.

91.2 Hydraulics

91.21 Distribution

91.211 Uniformity

The wastewater may be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform distribution to the surface area. At design average flow, the deviation from a calculated uniformly distributed volume per square foot (m^2) of the filter surface may not exceed plus or minus 10 percent at any point. All hydraulic factors involving proper distribution of wastewater on the filters must be carefully calculated. Such calculations must be submitted to the reviewing agency.

Reverse reaction nozzles or hydraulic brakes must be provided to not exceed the maximum speed recommended by the distributor manufacturer and to attain the desired media flushing rate.

91.212 Head Requirements

For reaction type distributors, a minimum head of 24 inches (610 mm) between low water level in the siphon chamber and center of the arms is required. Similar allowance in design must be provided for added pumping head requirements where pumping to the reaction type distributor is used.

91.213 Clearance

A minimum clearance of 12 inches (305 mm) between media and distributor arms must be provided.

91.22 Dosing

Wastewater may be applied to the filters by siphons, pumps or by gravity discharge from preceding treatment units when suitable flow characteristics have been developed. Application of the wastewater must be practically continuous. The piping system must be designed for recirculation.

91.23 Piping System

The piping system, including dosing equipment and distributor, must be designed to provide capacity for the design peak hourly flow rate, including recirculation required under Section 91.55.

91.3 Media

91.31 Quality

The media may be crushed rock, slag, or manufactured material. The media must be durable, resistant to spalling or flaking and relatively insoluble in wastewater. The top 18 inches (457 mm) may not have a loss by the 20-cycle, sodium sulfate soundness test of more than 10 percent, as prescribed by ASCE Manual of Engineering Practice, Number 13. The balance must pass a 10-cycle test using the same criteria. Slag media must be free from iron or other leachable materials that will adversely affect the process or effluent quality. Manufactured media must be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalies, organic compounds, and fungus and biological attack. This media must be structurally capable of supporting a person's weight or a suitable access walkway must be provided to allow for distributor maintenance.

91.32 Depth

Trickling filter media must have a depth of at least 6 feet (1.8 m) above the underdrains. Rock and/or slag filter media depths should not exceed 10 feet (3 m) and manufactured filter media depths may not exceed the recommendations of the manufacturer. Forced ventilation should be considered in accordance with Section 91.43.

91.33 Size, Grading and Handling of Media

91.331 Rock, Slag, and Similar Media

Rock, slag, and similar media may not contain more than 5 percent by weight of pieces with the longest dimension three times the least dimension. They must be free from thin, elongated and flat pieces, dust, clay, sand or fine material and must conform to the following size and grading when mechanically graded over a vibrating screen with square openings.

Passing 4 1/2 inch (114 mm) screen - 100% by weight
Retained on 3 inch (76 mm) screen - 95-100% by weight
Passing 2 inch (51 mm) screen - 0-2% by weight
Passing 1 inch (25 mm) screen - 0-1% by weight

91.332 Manufactured Media

Suitability will be evaluated on the basis of experience with installations handling similar wastes and loadings. To insure sufficient void clearances, media with specific surface areas of no more than 30 square feet per cubic foot (100 m^2/m^3) are acceptable for filters employed for carbonaceous reduction, and 45 square feet per cubic foot (150 m^2/m^3) for second stage ammonia reduction.

91.333 Handling and Placing of Media

Material delivered to the filter site must be stored on wood-planked or other approved clean, hard-surfaced areas. All material must be rehandled at the filter site and no material may be dumped directly into the filter. Crushed rock, slag, and similar media must be washed and rescreened or forked at the filter site to remove all fines. This material must be placed by hand to a depth of 12 inches (305 mm) above the tile underdrains. The remainder of material may be placed by means of belt conveyors or equally effective methods approved by the engineer. All material must be carefully placed so as not to damage the underdrains. Manufactured media must be handled and placed as approved by the engineer. Trucks, tractors, and other heavy equipment may not be driven over the filter during or after construction.

91.4 Underdrainage System

91.41 Arrangement

Underdrains with semicircular inverts or equivalent should be provided and when provided, the underdrainage system must cover the entire floor of the filter. Inlet openings into the underdrains must have an unsubmerged gross combined area equal to at least 15 percent of the surface area of the filter.

91.42 Hydraulic Capacity

The underdrains must have a slope of at least 1 percent. Effluent channels must be designed to produce a velocity of at least 2 feet per second (0.61 m/s) at design average flow rates of application to the filter including recirculated flows. Refer to Section 91.43.

91.43 Ventilation

The underdrainage system, effluent channels and effluent pipe must be designed to permit free passage of air. The size of drains, channels, and pipe should be such that not more than 50 percent of their cross-sectional area will be submerged under the design peak instantaneous flow, including proposed or possible future recirculated flows.

Forced ventilation should be provided for covered trickling filters to insure adequate oxygen for process requirements. Windows or simple louvered mechanisms arranged to ensure air distribution throughout the enclosure must be provided. The design of the ventilation facilities must provide for operator control of air flow in accordance with outside seasonal temperature. Design computations showing the adequacy of air flow to satisfy process oxygen requirements must be submitted.

91.44 Flushing

Provision should be made for flushing the underdrains unless high rate recirculation is utilized. In small rock and slag filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities should be provided.

91.5 Special Features

91.51 Flooding

Appropriate valves, sluice gates, or other structures must be provided to enable flooding of filters comprised of rock or slag media for filter fly control.

91.52 Freeboard

A freeboard of 4 feet (1.2 m) or more should be provided for tall, manufactured filters to contain windblown spray. Provide at least 6 foot (1.8 m) headroom for maintenance of the distributor on covered filters.

91.53 Maintenance

All distribution devices, underdrains, channels, and pipes must be installed so that they may be properly maintained, flushed or drained.

91.54 Winter Protection

Covers must be provided to maintain operation and treatment efficiencies when climatic conditions are expected to result in problems due to cold temperatures.

91.55 Recirculation

The piping system must be designed for recirculation as required to achieve the design efficiency. The recirculation rate must be variable and subject to plant operator control at the range of 0.5:1 up to 4:1 (ratio of recirculation rate versus design average flow). A minimum of two recirculation pumps must be provided.

91.56 Recirculation Measurement

Devices must be provided to permit measurement of the recirculation rate. Elapsed time meters and pump head recording devices are acceptable for facilities treating less than 1 MGD (3785 m^3/d). The design of the recirculation facilities must provide for both continuity of service and the range of recirculation ratios. Reduced recirculation rates for periods of brief pump outages may be acceptable depending on water quality requirements.

91.6 Rotary Distributor Seals

Mercury seals are not permitted. Ease of seal replacement must be considered in the design to ensure continuity of operation.

91.7 Unit Sizing

Required volumes of filter media must be based upon pilot testing with the particular wastewater or any of the various empirical design equations that have been verified through actual full scale experience. Such calculations must be submitted if pilot testing is not utilized. Pilot testing is recommended to verify performance predictions based upon the various design equations, particularly when significant amounts of industrial wastes are present.

Trickling filter design must consider peak organic load conditions including the oxygen demands due to recycle flows (i.e. heat treatment supernatant, vacuum filtrate, anaerobic digester supernatant, etc.) due to high concentrations of BOD_5 and TKN associated with such flows. The volume of media determined from either pilot plant studies or use of acceptable design equations must be based upon the design maximum day BOD_5 organic loading rate rather than the design average BOD_5 rate. Refer to Section 11.251.

92. ACTIVATED SLUDGE

92.1 General

92.11 Applicability

92.111 Biodegradable Wastes

The activated sludge process and its various modifications may be used where wastewater is amenable to biological treatment.

92.112 Operational Requirement

This process requires close attention and competent operating supervision, including routine laboratory control. These requirements must be considered when proposing this type of treatment.

92.113 Energy Requirements

This process requires major energy usage to meet aeration demands. Energy costs and potential mandatory emergency public power reduction events in relation to critical water quality conditions must be carefully evaluated. Capability of energy usage phasedown while still maintaining process viability, both under normal and emergency energy availability conditions, must be included in the activated sludge design.

92.12 Specific Process Selection

The activated sludge process and its several modifications may be employed to accomplish varied degrees of removal of suspended solids and reduction of carbonaceous and/or nitrogenous oxygen demand. Choice of the process most applicable will be influenced by the degree and consistency of treatment required, type of waste to be treated, proposed plant size, anticipated degree of operation and maintenance, and operating and capital costs. All designs must provide for flexibility in operation and should provide for operation in various modes, if feasible.

Extended aeration and oxidation ditch treatment facilities may be prone to the growth of filamentous organisms, which can adversely impact treatment efficiency. The design of extended aeration and oxidation ditch facilities must consider this potential problem, and should provide a means for control of filamentous organisms.

The fill and draw mode of the activated sludge process, commonly termed the Sequencing Batch Reactor, may be approved by the reviewing authority on a case-by-case basis under section 53.2. The design must be based on experience at other facilities. Continuity and reliability of treatment equal to that of the continuous flow through modes of the activated sludge process must be provided. The reviewing authority should be contacted for design guidance and criteria when such systems are being considered.

92.13 Winter Protection

In severe climates, protection against freezing should be incorporated into the design to ensure continuity of operation and performance. Insulation of the tanks by earthen banks should be considered.

92.2 Pretreatment

Where primary settling tanks are not used, effective removal or exclusion of grit, debris, excessive oil or grease, and screening of solids must be accomplished prior to the activated sludge process.

Where primary settling is used, provision must be made for discharging raw wastewater directly to the aeration tanks to facilitate plant start-up and operation during the initial stages of the plant's design life.

92.3 Aeration

92.31 Capacities and Permissible Loadings

The size of the aeration tank for any particular adaptation of the process must be determined by full scale experience, pilot plant studies, or rational calculations based mainly on food to microorganism ratio and mixed liquor suspended solids levels. Other factors, such as size of treatment plant, diurnal load variations, and degree of treatment required, must also be considered. In addition, temperature, pH and reactor dissolved oxygen must be considered when designing for nitrification. Calculations should be submitted to justify the basis for design of aeration tank capacity. Calculations using values differing substantially from those in the accompanying table should reference actual operational plants. Mixed liquor suspended solids levels greater than 5000 mg/L may be allowed providing adequate data is submitted showing the aeration and clarification system capable of supporting such levels.

When process design calculations are not submitted, the aeration tank capacities and permissible loadings for the several adaptations of the processes shown in the following table must be used. These values apply to plants receiving diurnal load ratios of design peak hourly BOD_5 to design average BOD_5 ranging from about 2:1 to 4:1. Thus, the utilization of flow equalization facilities to reduce the diurnal design peak hourly BOD_5 organic load may be considered by the appropriate reviewing agency as justification to approve organic loading rates that exceed those specified in the table.

PERMISSIBLE AERATION TANK CAPACITIES AND LOADINGS			
Process	****Aeration Tank Organic Loading lbs. BOD_5/d/1000 ft^3 (kg/d/m^3)***	F/M Ratio lb. BOD_5/day per lb. MLVSS ***	MLSS* mg/L
Conventional Step Aeration Complete Mix	40 (0.64)	0.2-0.5	1000-3000
Contact Stabilization	50** (0.8)	0.2-0.6	1000-3000
Extended Aeration Single Stage Nitrification	15 (0.24)	0.05-0.1	3000-5000

* MLSS values are dependent upon the surface area provided for sedimentation and the rate of sludge return as well as the aeration process.

** Total aeration capacity, includes both contact and reaeration capacities. Normally the contact zone equals 30 to 35% of the total aeration capacity.

*** Refer to 11.251(a) for definition of BOD.

**** Loadings are based on the organic load influent to the aeration tank at plant design average BOD_5.

92.32 Arrangement of Aeration Tanks

a. Dimensions

The dimensions of each independent mixed liquor aeration tank or return sludge reaeration tank must be such as to maintain effective mixing and utilization of air. Ordinarily, liquid depths should not be less than 10 feet (3 m) or more than 30 feet (9 m) except in special design cases. An exception is that horizontally mixed aeration tanks must have a depth of at least 5.5 feet (1.7 m).

b. Short-circuiting

For very small tanks or tanks with special configuration, the shape of the tank, the location of the influent and sludge return, and the installation of aeration equipment should provide for positive control to prevent short-circuiting through the tank.

92.321 Number of Units

Total aeration tank volume must be divided among two or more units, capable of independent operation, when required by the reviewing agency to meet applicable effluent limitations and reliability guidelines.

92.322 Inlets and Outlets

a. Controls

Inlets and outlets for each aeration tank unit must be suitably equipped with valves, gates, stop plates, weirs, or other devices to permit controlling the flow to any unit and to maintain reasonably constant liquid level.

The effluent weir for a horizontally mixed aeration tank system must be easily adjustable by mechanical means and must be sized based on the design peak instantaneous flow plus the maximum return sludge flow. Refer to Section 92.41. The hydraulic properties of the system must permit the design peak instantaneous flow to be carried with any single aeration tank unit out of service.

b. Conduits

Channels and pipes carrying liquids with solids in suspension must be designed to maintain self-cleansing velocities or must be agitated to keep such solids in suspension at all rates of flow within the design limits. Adequate provisions should be made to drain segments of channels which are not being used due to alternate flow patterns.

92.323 Freeboard

All aeration tanks should have a freeboard of not less than 18 inches (457 mm). However, if a mechanical surface aerator is used, the freeboard should be not less than 3 feet (914 mm) to protect against windblown spray freezing on walkways, etc.

92.33 Aeration Equipment

92.331 General

Oxygen requirements generally depend on maximum diurnal organic loading (design peak hourly BOD_5 as described in Section 11.25), degree of treatment, and level of suspended solids concentration to be maintained in the aeration tank mixed liquor. Aeration equipment must be capable of maintaining a minimum of 2.0 mg/l of dissolved oxygen in the mixed liquor at all times and provide thorough mixing of the mixed liquor. In the absence of experimentally determined values, the design oxygen requirements for all activated sludge processes must be 1.1 lbs. O_2/lb. design peak hourly BOD_5 applied to the aeration tanks (1.1 kg O_2/kg design peak hourly BOD_5), with the exception of the extended aeration process, for which the value must be 1.5 to include endogenous respiration requirements.

In the case of nitrification, the oxygen requirement for oxidizing ammonia must be added to the above requirement for carbonaceous BOD_5 removal and endogenous respiration requirements. The nitrogen oxygen demand (NOD) must be taken as 4.6 times the diurnal peak TKN content of the influent. In addition, the oxygen demands due to recycle flows (i.e., heat treatment supernatant, vacuum filtrate, elutriates, etc.) must be considered due to the high concentrations of BOD_5 and TKN associated with such flows.

Careful consideration should be given to maximizing oxygen utilization per unit power input. Unless flow equalization is provided, the aeration system should be designed to match the diurnal organic load variation while economizing on power input. Refer to Section 92.31

92.332 Diffused Air Systems

The diffused air system that provides the oxygen requirements must be designed according to either of the two methods described below in (a) and (b), augmented as required by consideration of items (c) through (h):

a. Having determined the oxygen requirements under Section 92.331, air requirements for a diffused air system must be determined by use of any of the well known equations incorporating such factors as:

   1. Tank depth;

   2. Alpha factor of waste;

   3. Beta factor of waste;

4. Certified aeration device transfer efficiency;

5. Minimum aeration tank dissolved oxygen concentration;

6. Critical wastewater temperature; and

7. Altitude of plant.

In the absence of experimentally determined alpha and beta factors, wastewater transfer efficiency must be assumed to be not greater than 50 percent of clean water efficiency for plants treating primarily (90% or greater) domestic wastewater. Treatment plants where the waste contains higher percentages of industrial wastes must use a correspondingly lower percentage of clean water efficiency and must submit calculations justifying a lower percentage. The design transfer efficiency should be included in the specifications.

b. Normal air requirements for all activated sludge processes except extended aeration (assuming equipment capable of transmitting to the mixed liquor the amount of oxygen required in Section 92.331) must be considered to be 1500 cubic feet at standard conditions of pressure, temperature, and humidity per pound of BOD_5 tank loading (94 m^3/kg of BOD_5). For the extended aeration process the value must be 2050 cubic feet per pound of BOD_5 (128 m^3/kg of BOD_5).

c. Air required for channels, pumps, aerobic digesters, filtrate, and supernatant or other air-use demand must be added to the air requirements calculated above.

d. The specified capacity of blowers or air compressors, particularly centrifugal blowers, should take into account that the air intake temperature may reach 115°F (46°C) or higher and the pressure may be less than normal. The specified capacity of the motor drive should also take into account that the intake air may be -20°F (-29°C) or less and may require over-sizing of the motor or a means of reducing the rate of air delivery to prevent overheating or damage to the motor.

e. The blowers must be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design must also provide for varying the volume of air delivered in proportion to the load demand of the plant. Aeration equipment must be easily adjustable in increments and must maintain solids suspension within these limits.

f. Diffuser systems must be capable of providing for 200 percent of the design average day oxygen demand. The air diffusion piping and diffuser system must be capable of delivering normal air requirements with minimal friction losses.

Air piping systems should be designed such that total head loss from blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 psi (3.4 kPa) at average operating conditions.

The spacing of diffusers should be in accordance with the oxygen requirements through the length of the channel or tank, and should be designed to facilitate adjustment of their spacing without major revisions to air header piping.

All plants having less than four independent aeration tanks must be designed to incorporate removable diffusers that can be serviced and/or replaced without dewatering the tank.

g. Individual assembly units of diffusers must be equipped with control valves, preferably with indicator markings for throttling, or for complete shutoff. Diffusers in any single assembly must have substantially uniform pressure loss.

h. Air filters must be provided in numbers, arrangements, and capacities to continuously furnish an air supply sufficiently free from dust to prevent damage to blowers and clogging of the diffuser system used.

92.333 Mechanical Aeration Systems

a. Oxygen Transfer Performance

The mechanism and drive unit must be designed for the expected conditions in the aeration tank in terms of the power performance. Certified testing must be provided to verify mechanical aerator performance. Refer to applicable provisions of Section 93.332. In the absence of specific design information, the oxygen requirements must be calculated using a transfer rate not to exceed 2 pounds of oxygen per horsepower per hour (1.22 kg O_2/kw/hr) in clean water under standard test conditions. Design transfer efficiencies must be included in the specifications.

b. Design Requirements

The design requirements of a mechanical aeration system must accomplish the following:

1. Maintain a minimum of 2.0 mg/L of dissolved oxygen in the mixed liquor at all times throughout the tank or basin;

2. Maintain all biological solids in suspension (for a horizontally mixed aeration tank system an average velocity of 1 foot per second [0.3 m/sec] must be maintained);

3. Meet maximum oxygen demand and maintain process performance with the largest unit out of service;

4. Provide for varying the amount of oxygen transferred in proportion to the load demand on the plant; and

5. Provide that motors, gear housing, bearings, grease fittings, etc., be easily accessible and protected from inundation and spray as necessary for proper functioning of the unit.

c. Winter Protection

Where extended cold weather conditions occur, the aerator mechanism and associated structure must be protected from freezing due to splashing. Due to high heat loss, subsequent treatment units must be protected from freezing.

92.4 Return Sludge Equipment

92.41 Return Sludge Rate

The minimum permissible return sludge rate of withdrawal from the final settling tank is a function of the concentration of suspended solids in the mixed liquor entering it, the sludge volume index of these solids, and the length of time these solids are retained in the settling tank. Since undue retention of solids in the final settling tanks may be deleterious to both the aeration and sedimentation phases of the activated sludge process, the rate of sludge return expressed as a percentage of the design average daily flow (ADF) of wastewater should generally be variable between the limits set forth as follows:

Type of Process	% ADF Minimum	% ADF Maximum
Conventional	15	100
Carbonaceous Stage of Separate Stage Nitrification	15	100
Step Aeration	15	100
Contact Stabilization	50	150
Extended Aeration	50	150
Nitrification Stage of Separate Stage Nitrification	50	200

The rate of sludge return must be varied by means of variable speed motors, drives, or timers (small plants) to pump sludge at the above rates.

92.42 Return Sludge Pumps

If motor driven return sludge pumps are used, the maximum return sludge capacity must be obtained with the largest pump out of service. A positive head should be provided on pump suctions. Pumps should have at least 3 inch (76 mm) suction and discharge openings.

If air lifts are used for returning sludge from each settling tank hopper, no standby unit will be required provided the design of the air lifts facilitate their rapid and easy cleaning and provided other suitable standby measures are provided. Air lifts should be at least 3 inches (76 mm) in diameter.

92.43 Return Sludge Piping

Discharge piping should be at least 4 inches (102 mm) in diameter and should be designed to maintain a velocity of not less than 2 feet per second (0.61 m/s) when return sludge facilities are operating at normal return sludge rates. Suitable devices for observing, sampling, and controlling return activated sludge flow from each settling tank hopper must be provided, as outlined in Section 73.24.

92.44 Waste Sludge Facilities

Waste sludge control facilities should have a capacity of at least 25 percent of the design average rate of wastewater flow and function satisfactorily at rates of 0.5 percent of design average wastewater flow or a minimum of 10 gallons per minute (0.63 l/s), whichever is larger.
Means for observing, measuring, sampling, and controlling waste activated sludge flow must be provided. Waste sludge may be discharged to the concentration or thickening tank, primary settling tank, sludge digestion tank, vacuum filters, or any practical combination of these units.

92.5 Measuring Devices

Devices should be installed in all plants for indicating flow rates of raw wastewater or primary effluent, return sludge, and air to each tank unit. For plants designed for design average wastewater flows of 1 MGD (3785 m^3/d) or more, these devices should totalize and record, as well as indicate flows. Where the design provides for all return sludge to be mixed with the raw wastewater (or primary effluent) at one location, then the mixed liquor flow rate to each aeration unit should be measured.

93. WASTEWATER TR EATMENT PONDS

93.1 General

This Section deals with generally used variations of treatment ponds capable of achieving secondary treatment including controlled-discharge pond systems, flow-through pond systems and aerated pond systems. Ponds utilized for equalization, percolation, and sludge storage are not discussed in this Section.

93.2 Location

93.21 Distance from Habitation

A pond site should be located as far as practicable, with a recommended minimum of 1/4 mile (0.4 km), from human habitation or from any area that may be built up within the foreseeable future. Consideration should be given to site specifics including but not limited to vector transport, odor, public safety, topography, prevailing winds, and forest.

93.22 Surface Runoff

Adequate provision must be made to divert stormwater runoff around the ponds and protect pond embankments from erosion.

93.23 Soil Borings

Data from soil borings conducted by an independent soil testing laboratory to determine subsurface soil characteristics and groundwater characteristics (including elevation and flow) of the proposed site and their effect on the construction and operation of a pond must also be provided.

93.24 Groundwater Separation

A minimum separation of 4 feet (1.2 m) between the bottom of the pond and the maximum groundwater elevation should be maintained.

93.25 Bedrock Separation

A minimum separation of 10 feet (3.0 m) between the pond bottom and any bedrock formation is recommended.

93.3 Basis of Design

93.31 Area and Loadings for Co ntinuous and Controlled-Discharge Facultative Treatment Pond Systems

See Table 93-1 for design criteria.

93.32 Aerated Treatment Pond Systems

For the development of final design parameters, it is recommended that actual experimental data be developed; however the aerated treatment pond system design for minimum detention time may be estimated using the following formula applied separately to each aerated cell:

$$t = \frac{E}{2.3K_1 \times (100-E)}$$

t = detention time, days

E = percent of BOD_5 to be removed in an aerated pond

K_1 = reaction coefficient, aerated lagoon, base 10. For normal domestic wastewater, the K_1 value may be assumed to be 0.12/day at 68° F (20° C) and 0.06/day at 34° F (1° C)

The reaction rate coefficient for domestic wastewater, which includes some industrial wastes, other wastes, and partially treated wastewater must be determined experimentally for various conditions which might be encountered in the aerated ponds. Conversion of the reaction rate coefficient at other temperatures must be made based on experimental data.

Raw wastewater strength should also consider the effect of any return sludge. Also, additional storage volume should be considered for sludge, and in northern climates, ice cover.

Design should consider recirculation within the system.

Oxygen requirements generally will depend on the design average BOD_5 loading, the degree of treatment, and the concentration of suspended solids to be maintained. Aeration equipment must be capable of maintaining a minimum dissolved oxygen level of 2 mg/l in the ponds at all times and should also be capable of increasing the dissolved oxygen level for periodic upsets. Suitable protection from weather must be provided for electrical controls.

See Table 93-2 for design criteria.
See Section 92.33 for details on aeration equipment.

93.33 Industrial Wastes

Consideration must be given to the type of industrial wastes and effects on the treatment process. In some cases it may be necessary to pretreat industrial or other discharges.

Industrial wastes may not be discharged to ponds without assessment of the effects these substances may have upon the treatment process or discharge requirements in accordance with state and federal laws.

93.34 Number of Cells Required

At a minimum, a wastewater treatment pond system should consist of 3 cells designed to facilitate both series and parallel operations. The maximum size of a pond cell should be 40 acres (16 ha). Two-cell systems may be utilized in very small installations (approximately 25,000 gallons/day or less).

All systems should be designed with piping flexibility to permit isolation of any cell without affecting the transfer and discharge capabilities of the total system. In addition, the ability to discharge the influent waste load to a minimum of 2 cells and/or all primary cells in the system should be provided.

93.341 Controlled-Discharge Facultative Treatment Pond Systems

For controlled-discharge systems the area specified as the primary ponds should be equally divided into two cells. The third or secondary cell volume should as a minimum, be equal to the volume of each of the primary cells.

93.342 Flow-Through Facultative Treatment Pond Systems

At a minimum, primary cells must provide adequate detention time to maximize BOD_5 removal. Secondary cells should then be provided for additional detention time with depths to 8 feet (2.4 m) to facilitate solids reduction.

93.35 Pond Shape

The shape of all cells should be such that there are no narrow or elongated portions. Rectangular ponds (length not exceeding three times the width) are considered most desirable. Islands, peninsulas and coves are not permitted. Dikes should be rounded at corners to minimize accumulations of floating materials. Common-wall dike construction, wherever possible, is strongly encouraged.

93.36 Pond Criteria

The following tables summarize the criteria for facultative and aerated ponds.

TABLE 93-1
FACULTATIVE POND CRITERIA

	Disposal Method			
	Continuous Discharge	Controlled Discharge	Land Application	Total Retention[6]
Primary Cells				
Minimum Number[1]	2	2	1	1
BOD_5 Loading, lb/acre/day	15-35	15-35	15-35	15-35
Normal Operating Range Limits[2], feet	2-6	2-6	2-6	2-6
Detention Time, days	40-80	40-80	40-80	40-80
Maximum Seepage Rate[2] inches/year	6	6	6	6
Secondary or Storage Cells				
Minimum Number	1	1	1	1
Maximum Depth without Aeration, ft	8	8	8	8
Minimum Depth, feet	2	2	2	2
Maximum Seepage Rate, inches/year	6	6	6	6
Overall System				
Maximum BOD_5 Loading, lb/acre/day	20	20	20	20
Minimum Detention Time, days[2]	180	180	90-120	Total Retention [4,5]
Emergency or Winter Storage	N/A	N/A	60-150[3,4]	

1. All primary cells must be approximately equal in size.
2. Primary cell detention times must be based on volume between the 2 foot level and maximum depth. Secondary and storage cell detention times may be based on volume between the 1- foot level and maximum depth.
3. Shorter time periods for infiltration/percolation disposal and longer time periods for irrigation.
4. A month-by-month water balance must be submitted for land application and total retention.
5. Net evaporation rate must be calculated by using mean annual lake evaporation rate and the 10-year return period for annual precipitation and distribute it monthly based on the ratio of average monthly to average annual precipitation. Net loss for pond sizing would also include the allowable annual seepage rate for the pond site.
6. Total retention systems must be designed for at least 2 cells, and must be designed to remain full within the 2 to 6-foot water surface level at minimum expected flows.

TABLE 93-2 PARTIALLY MIXED AERATED POND CRITERIA			
	Disposal Method		
	Continuous Discharge	Controlled Discharge	Land Application
Minimum Number of Aerated Cells[1]	3	3	1-2[2]
Recommended Mode of Aeration[3]	Tapered	Tapered	Equal
Minimum System Oxygen Requirements, lbs 0_2 / lb BOD_5 removed[4]	2.5	2.5	2.5
Minimum Dissolved Oxygen, mg/l[5]	2.0	2.0	2.0
Depth, feet	10-15	10-15	10-15
Minimum Detention Time Under Aeration, days[6]	20	20	15
Maximum Seepage Rate, inches/year	6	6	6
Emergency Storage for Infiltration/ Percolation, days	N/A	N/A	30-90
Winter Storage for Irrigation	N/A	N/A	See foot- note 7
Mixing in Aerated Cells, Hp/MG	5-10	5-10	5-10

1. The outlet area of all final cells must have a quiescent zone of at least one to two days hydraulic detention time for settling solids.
2. One aeration cell if large storage cell is proposed. Two aeration cells if infiltration/percolation is proposed.
3. If first cell is out of service, sufficient oxygen must be dispersed in remaining cells to keep cells aerobic.
4. Criteria for Primary Cells: Oxygen supplied must be sufficient to meet the organic, nitrogenous, benthic and algal demands in the pond.
5. Measured two feet below the surface of the pond.
6. Base design on provisions of Section 93.32. Detention time must be sufficient to provide adequate BOD reduction to meet waste discharge requirements. Volume calculated from two feet from bottom to maximum depth. Time not inclusive of quiescent zone. Waste load and climatic conditions may require more stringent criteria.
7. A month-by-month water balance must be submitted with each land application plan to determine winter storage.

93.4 Pond Construction Details

93.41 Embankments and Dikes

93.411 Material

Dikes must be constructed of relatively impervious soil and compacted to at least 90 percent Standard Proctor Density, or as recommended by a geotechnical engineer, to form a stable structure. Vegetation and other unsuitable materials must be removed from the area where the embankment is to be placed.

93.412 Top Width

The minimum dike width is 8 feet (2.4 m) to permit access for maintenance vehicles.

93.413 Maximum Slopes

Inner and outer dike slopes may not be steeper than 1 vertical to 3 horizontal (1:3).

93.414 Minimum Slopes

Inner slopes should not be flatter than 1 vertical to 4 horizontal (1:4). Flatter slopes can be specified for larger installations because of wave action but have the disadvantage of added low areas being conducive to emergent vegetation. Outer slopes must be sufficient to prevent surface runoff from entering the ponds.

93.415 Freeboard

Freeboard must be at least 3 feet (914 mm), except that for small systems 2 feet (610 mm) may be acceptable.

93.416 Erosion Control

All lagoons must be protected from erosion caused by wave action, weather and flooding. A justification and detailed discussion of the method of erosion control which encompasses all relative factors such as pond location and size, seal material, topography, prevailing winds, cost breakdown, application procedures, etc., must be provided. Lagoons with proposed uncovered synthetic liners must include provisions to reduce the hazard associated with the slick surface.

a. Seeding

The dikes must have a cover layer of at least 4 inches (102 mm) of fertile topsoil to promote establishment of an adequate vegetative cover wherever riprap or synthetic liner is not utilized. Perennial-type, low-growing, spreading grasses that minimize erosion and can be mowed are most satisfactory for seeding on dikes. In general, alfalfa and other long-rooted crops should not be used for seeding since the roots of this type are apt to impair the water-holding efficiency of the dikes.

b. Additional Erosion Protection

Riprap or some other acceptable method of erosion control is required as a minimum around all piping entrances and exits and on interior dike slopes of all lagoons utilizing soil liners except very small systems. Where justified, riprap can be limited to interior dikes receiving prevailing winds. Riprap, or an acceptable equal, must be placed from one foot above the high water mark to two feet below the low water mark (measured on the vertical). For aerated cells the design should ensure erosion protection on the slopes and bottoms in the areas where turbulence will occur. Additional erosion control may also be necessary on the exterior dike slope to protect the embankment from erosion due to severe flooding of a watercourse.

93.42 Pond Bottom

93.421 Soil

Soil used in constructing the pond bottom (not including the seal) and dike cores must be tight and compacted at or up to 4 percent above the optimum water content to at least 90 percent Standard Proctor Density or as recommended by a geotechnical engineer.

93.422 Seal

Ponds must be sealed so that seepage loss through the seal is as low as practicably possible. Seals consisting of soils, bentonite, or synthetic liners may be considered provided the permeability, durability, and integrity of the proposed material can be satisfactorily demonstrated for anticipated conditions. Results of a testing program that substantiate the adequacy of the proposed seal must be incorporated into and/or accompany the engineering report. Testing must take place at the maximum operating depth. Standard ASTM procedures or acceptable similar methods must be used for all tests.

To achieve an adequate seal in systems using soil, bentonite, or other seal materials, the coefficient of permeability (k) in centimeters per second specified for the seal may not exceed the value derived from the following expression:

$$k = 3.0 \times 10^{-9} L$$

Where L equals the thickness of the seal in centimeters, the "k" obtained by the above expression corresponds to a percolation rate of pond water of less than 500 gallons per day per acre (4.68 m^3/ha/d) at a water depth of six feet (1.8 m). For a seal consisting of a synthetic liner, seepage loss through the liner may not exceed the quantity equivalent to seepage loss through an adequate soil seal.

93.423 Uniformity

Finished elevations for soil and bentonite liners may not vary more than 3 inches (76 mm) from the average elevation of the bottom and should be as level as possible. Sloped pond bottoms are allowed for synthetic liners, however they must be uniformly sloped.

93.424 Prefilling

Prefilling the pond should be considered in order to protect the liner, to prevent weed growth, to reduce odor, and to maintain moisture content of the seal. However, the dikes must be completely prepared as described in Sections 93.416 (a) and (b) before the introduction of water.

93.43 Influent Lines

93.431 Material

Generally accepted material for underground sewer construction will be given consideration for the influent line to the pond. Corrugated metal pipe must not be used due to corrosion problems. In material selection, consideration must be given to the characteristics of the wastes, exceptionally heavy external loadings, abrasion, soft foundations, and similar problems.

93.432 Manhole

A manhole or vented clean-out wye must be installed prior to entrance of the influent line into the primary cell and must be located as close to the dike as topography permits. Its invert must be at least 6 inches (152 mm) above the maximum operating level of the pond and provide sufficient hydraulic head without surcharging the manhole.

93.433 Flow Distribution

Flow distribution structures must be designed to effectively split hydraulic and organic loads equally to primary cells.

93.434 Placement

Influent lines must be located along the bottom of the pond and be adequately supported.

93.435 Point of Discharge

All primary cells must have individual influent lines which terminate approximately at the midpoint of the width and at approximately 10 feet from the toe of the dike slope and be located as far as possible from the outlet structure to minimize short-circuiting.

All aerated cells must have influent lines that distribute the load within the mixing zone of aeration equipment.

93.436 Influent Discharge Apron

The influent line must discharge onto a concrete apron.

The end of the discharge line must rest on a suitable concrete apron large enough to prevent the terminal influent velocity at the end of the apron from causing soil erosion. A minimum size apron of 25 square feet must be provided.

93.44 Control Structures and Interconnecting Piping

93.441 Structure

Where possible, facility design must consider the use of multi-purpose control structures to facilitate normal operational functions such as drawdown and flow distribution, flow and depth measurement, sampling, pumps for recirculation, chemical additions and mixing, and minimization of the number of construction sites within the dikes.

At a minimum, control structures must be: (a) accessible for maintenance and adjustment of controls; (b) adequately ventilated for safety and to minimize corrosion; (c) locked to discourage vandalism; (d) contain controls to permit water level and flow rate control, and complete shutoff; (e) constructed of non-corrodible materials (metal-on-metal contact in controls should be of similar alloys to discourage electrochemical reactions); and (f) located to minimize short-circuiting within the cell and avoid freezing and ice damage.

Recommended devices to regulate water level are valves, slide tubes or dual slide gates. Stop logs are not to be used to regulate water levels. Regulators should be designed so that they can be preset to prevent the pond surface elevation from dropping below the desired operational level.

93.442 Piping

All piping must be of ductile iron, PVC or other acceptable material. Pipes should be anchored with adequate erosion control. All interpond piping and takeoffs must be submerged.

a. Drawdown Structure Piping

1. Single Takeoffs for the final treatment pond

For ponds designed for shallow depth operations (6 feet or less), single takeoffs are allowed. The intake of the takeoff must be located 10 feet (3.0 m) from the toe of the dike and a minimum of 2 feet (610 mm) from the bottom of the pond and shall employ vertical withdrawl.

2. Multi-Level Takeoffs for the final treatment pond

   For ponds that are variable in depth or designed deep enough to permit stratification of pond content, multiple takeoffs are required. Three withdrawal pipes at different elevations are recommended. The bottom pipe must be located 10 feet (3.0m) from the toe of the dike and 2 feet (610mm) from the bottom of the pond and shall employ vertical withdrawl. The other pipes must be located a minimum of 2 feet from the edge of the dike and should utilize horizontal entrance. Adequate structural support must be provided.

3. Emergency Overflow
   To prevent overtopping of dikes, emergency overflow should be provided with capacity to carry the peak instantaneous flow expected.

4. Piping flexibility must allow any cell to be taken out of service while maintaining a minimum series operation for the remaining cells.

b. Hydraulic Capacity

   The hydraulic capacity for continuous discharge structures and piping must allow for a minimum of 250 percent of the design maximum day flow of the system.
   The hydraulic capacity for controlled-discharge systems must permit transfer of water at a minimum rate of six inches (152 mm) of pond water depth per day at the available head.

93.5 Miscellaneous

93.51 Fencing

The pond area must be enclosed with an adequate fence to prevent entering of livestock and discourage trespassing. Chain link fencing or equivalent should be seriously considered for lagoons near urban areas. Fencing should not obstruct maintenance vehicle traffic on top of the dikes. A vehicle access gate of sufficient width to accommodate mowing equipment must be provided. All access gates must be provided with locks.

93.52 Access

An all-weather access road must be provided to the pond site to allow year-round maintenance of the facility.

93.53 Warning Signs

Appropriate permanent signs must be provided along the fence around the pond to designate the nature of the facility and advise against trespassing. At least one sign must be provided on each side of the site and one for every 500 feet (150 m) of its perimeter.

93.54 Flow Measurement

Flow measurement requirements are presented in Section 56.6. Effective weather protection must be provided for the recording equipment.

93.55 Groundwater Monitoring

An approved system of wells or lysimeters may be required around the perimeter of the pond site to facilitate groundwater monitoring. The need for such monitoring will be determined on a case-by-case basis.

93.56 Pond Level Gauges

Pond level gauges must be provided.

93.57 Service Building

A service building for laboratory and maintenance equipment must be provided if required in Section 58.

93.58 Sulfate Content of Water Supply

Non-aerated lagoons should not be used if excessive sulfate is present in the wastewater.

94. ROTATING BIOLOGICAL CONTACTORS

94.1 General

94.11 Applicability

The Rotating Biological Contactor (RBC) process may be used where sewage is amenable to biological treatment. The process may be used to accomplish carbonaceous and/or nitrogenous oxygen demand reductions. Design standards, operating data and experience for this process are not well established. Therefore, expected performance of RBC's must be based upon experience at similar full scale installations or thoroughly documented pilot testing with the particular wastewater.

94.12 Winter Protection

Wastewater temperature affects rotating contractor performance. Year-round operation in colder climates requires that rotating contractors be covered to protect the biological growth from cold temperatures and the excessive loss of heat from the wastewater with the resulting loss of performance.

Enclosures must be constructed of a suitable corrosion resistant material. Windows or simple louvered mechanisms that can be opened in the summer and closed in the winter must be installed to provide adequate ventilation. To minimize condensation, the enclosure should be adequately insulated and/or heated.

94.2 Required Pretreatment

RBC's must be preceded by effective settling tanks equipped with scum and grease collecting devices unless substantial justification is submitted for other pretreatment devices which provide for effective removal of grit, debris and excessive oil or grease prior to the RBC units. Bar screening or comminution are not suitable as the sole means of pretreatment.

94.3 Unit Sizing

Unit sizing must be based on experience at similar full-scale installations or thoroughly documented pilot testing with the particular wastewater. In determining design loading rates, expressed in units of volume per day per unit area of media covered by biological growth, the following parameters must be considered:

a. Design flow rate and influent waste strength;

b. Percentage of BOD to be removed;

c. Media arrangement, including number of stages and unit area in each state;

d. Rotational velocity of the media;

e. Retention time within the tank containing the media;

f. Wastewater temperature; and

g. Percentage of influent BOD which is soluble.

In addition to the above parameters, loading rates for nitrification will depend upon influent total kjeldahl nitrogen (TKN), pH, and the allowable effluent ammonia nitrogen concentration.

94.4 Design Safety Factor

Effluent concentrations of ammonia nitrogen from the RBC process designed for nitrification are affected by diurnal load variations. Therefore, it may be necessary to increase the design surface area proportional to the ammonia nitrogen diurnal peaking rates to meet effluent limitations. An alternative is to provide flow equalization sufficient to ensure process performance within the required effluent limitations.

95. OTHER BIOLOGICAL SYSTEMS

95.1 General

Biological treatment processes not included in these standards may be considered in accordance with Section 53.2.

CHAPTER 100
DISINFECTION

101. GENERAL

Disinfection of the effluent must be provided as necessary to meet applicable standards. The design must meet both the bacterial standards and the disinfectant residual limit in the effluent. The disinfection process should be selected after due consideration of waste characteristics, type of treatment process provided prior to disinfection, waste flow rates, pH of waste, disinfectant demand rates, current technology application, cost of equipment and chemicals, power cost, and maintenance requirements.

Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid chlorine and calcium or sodium hypochlorite. Other disinfectants, including chlorine dioxide, ozone, bromine, or ultraviolet disinfection, may be accepted by the approving authority in individual cases. If halogens are utilized, it may be necessary to dehalogenate if the residual level in the effluent exceeds effluent limitations or would impair the natural aquatic habitat of the receiving stream.

Municipalities are encouraged to investigate the use of U.V. disinfection due to safety and toxicity benefits.

Where a disinfection process other than chlorine is proposed, supporting data from pilot plant installations or similar full scale installations may be required as a basis for the design of the system.

102. CHLORINE DISINFECTION

102.1 Type

Chlorine is available for disinfection in gas, liquid (hypochlorite solution), and pellet (hypochlorite tablet) form. The type of chlorine should be carefully evaluated during the facility planning process. The use of chlorine gas or liquid will be most dependent on the size of the facility and the chlorine dose required. Large quantities of chlorine, such as are contained in ton cylinders and tank cars, can present a considerable hazard to plant personnel and to the surrounding area, should such containers develop leaks. Both monetary costs and the potential public exposure to chlorine should be considered when making the final determination.

102.2 Dosage

For disinfection, the capacity must be adequate to produce an effluent that will meet the coliform limits specified by the regulatory agency for that installation. Required disinfection capacity will vary, depending on the uses and points of application of the disinfection chemical. The chlorination system must be designed on a rational basis and calculations justifying the equipment sizing and number of units must be submitted for the whole operating range of flow rates for the type of control to be used. System design considerations must include the controlling wastewater flow meter (sensitivity and location), telemetering equipment and chlorination controls. For normal domestic sewage, the following may be used as a guide in sizing chlorination facilities:

Type of Treatment	Dosage
Trickling filter plant effluent	10 mg/L
Activated sludge plant effluent	8 mg/L
Tertiary filtration effluent	6 mg/L
Nitrified effluent	6 mg/L

102.3 Containers

102.31 Cylinders

150 pound (68 kg) cylinders are typically used where chlorine gas consumption is less than 150 pounds per day (68 kg/day). Cylinders should be stored in an upright position with adequate support brackets and chains at 2/3 of cylinder height for each cylinder.

102.32 Ton Containers

The use of one-ton (909 kg) containers should be considered where the average daily chlorine consumption is over 150 pounds (68 kg).

102.33 Liquid Hypochlorite Solutions

Storage containers for hypochlorite solutions must be of sturdy, non-metallic lined construction and must be provided with secure tank tops and pressure relief and overflow piping. Storage tanks should be either located or vented outside. Provision must be made for adequate protection from light and extreme temperatures. Tanks must be located where leakage will not cause corrosion or damage to other equipment. A means of secondary containment must be provided to contain spills and facilitate cleanup. Due to deterioration of hypochlorite solutions over time, it is recommended that containers not be sized to hold more than one month's needs. At larger facilities and locations where delivery is not a problem, it may be desirable to limit on-site storage to one week. Refer to Section 57.

102.34 Dry Hypochlorite Compounds

Dry hypochlorite compounds should be kept in tightly closed containers and stored in a cool, dry location. Some means of dust control should be considered, depending on the size of the facility and the quantity of compound used. Refer to Section 57.

102.4 Equipment

102.41 Scales

Scales for weighing cylinders must be provided at all plants using chlorine gas. At large plants, scales of the indicating and recording type are recommended. At least a platform scale must be provided. Scales must be of corrosion-resistant material.

102.42 Evaporators

Where manifolding of several cylinders or ton containers will be required to evaporate sufficient chlorine, consideration should be given to the installation of evaporators to produce the quantity of gas required.

102.43 Mixing

The disinfectant must be positively mixed as rapidly as possible, with a complete mix being effected in 3 seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer.

102.44 Contact Period and Tank

For a chlorination system, a minimum contact period of 15 minutes at design peak hourly flow or maximum rate of pumpage must be provided after thorough mixing. For evaluation of existing chlorine contact tanks, field tracer studies should be done to assure adequate contact time.

The chlorine contact tank must be constructed so as to reduce short-circuiting of flow to a practical minimum. Tanks not provided with continuous mixing must be provided with "over-and-under" or "end-around" baffling to minimize short-circuiting.

The tank should be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection. Duplicate tanks, mechanical scrapers, or portable deck-level vacuum cleaning equipment must be provided. Consideration should be given to providing skimming devices on all contact tanks. Covered tanks are discouraged.

102.45 Piping and Connections

Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for chlorine service, with a minimum number of joints. Piping should be well supported and protected against temperature extremes.

Due to the corrosiveness of wet chlorine, all lines designated to handle dry chlorine must be protected from the entrance of water or air containing water. Even minute traces of water added to chlorine results in a corrosive attack. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinylchloride (PVC), or other approved materials are satisfactory for wet chlorine or aqueous solutions of chlorine.

102.46 Standby Equipment and Spare Parts

Standby equipment of sufficient capacity should be available to replace the largest unit during shutdowns. Spare parts must be available for all disinfection equipment to replace parts that are subject to wear and breakage.

102.47 Chlorinator Water Supply

An ample supply of water must be available for operating the chlorinator. Where a booster pump is required, duplicate equipment should be provided, and, when necessary, standby power as well. Protection of a potable water supply must conform to the requirements of Section 56.2. Adequately filtered plant effluent should be considered for use in the chlorinator.

102.48 Leak Detection and Controls

A bottle of 56 percent ammonium hydroxide solution must be available for detecting chlorine leaks. Where ton containers (909 kg) or tank cars are used, a leak repair kit approved by the Chlorine Institute must be provided. Consideration should be given to the provision of caustic soda solution reaction tanks for absorbing the contents of leaking one-ton (909 kg) containers where such containers are in use. At large chlorination installations, consideration should be given to the installation of automatic gas detection and related alarm equipment.

102.5 Housing

102.51 Feed and Storage Rooms

If gas chlorination equipment or chlorine cylinders are to be in a building used for other purposes, a gas-tight room must separate this equipment from any other portion of the building. Floor drains from the chlorine room may not be connected to floor drains from other rooms. Doors to this room may open only to the outside of the building, and must be equipped with panic hardware. Chlorine rooms must be at ground level, and should permit easy access to all equipment. Storage areas for 1-ton (909 kg) cylinders should be separated from the feed area. In addition, the storage area must have designated areas for "full" and "empty" cylinders. Chlorination equipment should be situated as close to the application point as reasonably possible. For additional safety considerations, refer to Section 57.

102.52 Inspection Window

A clear glass, gas-tight, window must be installed in an exterior door or interior wall of the chlorinator room to permit the units to be viewed without entering the room.

102.53 Heat

Rooms containing disinfection equipment must be provided with a means of heating so that a temperature of at least 60 F (16 C) can be maintained. The room should be protected from excess heat. Cylinders must be kept at essentially room temperature.

102.54 Ventilation and Accidenta l Release

With chlorination systems, forced, mechanical ventilation must be installed that will provide one complete air change per minute when the room is occupied. The entrance to the air exhaust duct from the room must be near the floor and the point of discharge must be located so as not to contaminate the air inlet to any buildings or inhabited areas. Air inlets must be located so as to provide cross ventilation with air and at such temperature that will not adversely affect the chlorination equipment. The outside air inlet must be at least three feet above grade. The vent hose from the chlorinator must discharge to the outside atmosphere above grade. Where public exposure may be extensive, scrubbers may be required on ventilation discharge.

See the Uniform Fire Code requirements for treatment of gases as:

Treatment systems may be necessary to handle the accidental release of gas.

Treatment systems may be necessary to process all exhaust ventilation to be discharged from gas cabinets, exhausted enclosures or separate gas storage rooms.

102.55 Electrical Controls

Switches for fans and lights must be outside of the room at the entrance. A labeled signal light indicating fan operation must be provided at each entrance, if the fan can be controlled from more than one point.

102.56 Protective and Respiratory Gear

Respiratory air-pac protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH), must be available where chlorine gas is handled, and must be stored at a convenient location, but not inside any room where chlorine is used or stored. Instructions for using the equipment must be posted. The units must use compressed air, have at least 30-minute capacity and be compatible with the units used by the fire department responsible for the plant.

102.6 Sampling and Control

102.61 Sampling

Facilities must be included for sampling disinfected effluent after contact. In large installations, or where stream conditions warrant, provisions should be made for continuous monitoring of effluent chlorine residual.

102.62 Testing and Control

Equipment must be provided for measuring chlorine residual using accepted test procedures. The installation of demonstrated effective facilities for automatic chlorine residual analysis, recording, and proportioning systems should be considered at all large installations.

Equipment must also be provided for measuring fecal coliform organisms, using accepted test procedures as required by the regulatory agency.

103. DECHLORINATION

103.1 Types

Dechlorination of wastewater effluent may be necessary to reduce the toxicity due to chlorine residuals. The most common dechlorination chemicals are sulfur compounds, particularly sulfur dioxide gas or aqueous solutions of sulfite or bisulfite. Pellet dechlorination systems are also available for small facilities.

The type of dechlorination system should be carefully selected considering criteria including the following: type of chemical storage required, amount of chemical needed, ease of operation, compatibility with existing equipment, and safety.

103.2 Dosage

The dosage of dechlorination chemical should depend on the residual chlorine in the effluent, the final residual chlorine limit, and the particular form of the dechlorinating chemical used. The most common dechlorinating agent is sulfite. The following forms of the compound are commonly used and yield sulfite (SO_2) when dissolved in water.

Dechlorination Chemical	Theoretical mg/L Required to Neutralize 1 mg/L Cl_2
Sulfur dioxide (gas)	0.9
Sodium meta bisulfite (solution)	1.34
Sodium bisulfite (solution)	1.46

Theoretical values may be used for initial approximations, to size feed equipment with the consideration that under good mixing conditions 10% excess dechlorinating chemical is required above theoretical values. Excess sulfur dioxide may consume oxygen at a maximum of 1.0 mg dissolved oxygen for every 4 mg SO_2.

The liquid solutions come in various strengths. These solutions may need to be further diluted to provide the proper dose of sulfite.

103.3 Containers

Depending on the chemical selected for dechlorination, the storage containers will vary from gas cylinders, liquid in 50 gallon (190 L) drums or dry compounds. Dilution tanks and mixing tanks will be necessary when using dry compounds and may be necessary when using liquid compounds to deliver the proper dosage. Solution containers should be covered to prevent evaporation and spills.

103.4 Feed Equipment, Mixing, and Contact Requirements

103.41 Equipment

In general, the same type of feeding equipment used for chlorine gas may be used with minor modifications for sulfur dioxide gas. However, the manufacturer should be contacted for specific equipment recommendations. No equipment should be alternately used for the two gases. The common type of dechlorination feed equipment utilizing sulfur compounds include vacuum solution feed of sulfur dioxide gas and a positive displacement pump for aqueous solutions of sulfite or bisulfite.

The selection of the type of feed equipment utilizing sulfur compounds must include consideration of the operator safety and overall public safety relative to the wastewater treatment plant's proximity to populated areas and the security of gas cylinder storage. The selection and design of sulfur dioxide feeding equipment must take into account that the gas reliquifies quite easily. Special precautions must be taken when using ton (909 kg) containers to prevent reliquification.

Where necessary to meet the operating ranges, multiple units must be provided for adequate peak capacity and to provide a sufficiently low feed rate on turn down to avoid depletion of the dissolved oxygen concentrations in the receiving waters.

103.42 Mixing Requirements

The dechlorination reaction with free or combined chlorine will generally occur within 15-20 seconds. Mechanical mixers are required unless the mixing facility will provide the required hydraulic turbulence to assure thorough and complete mixing. The high solubility of SO_2 prevents it from escaping during turbulence.

103.43 Contact Time

A minimum of 30 seconds for mixing and contact time must be provided at the design peak hourly flow or maximum rate of pumpage. A suitable sampling point must be provided downstream of the contact zone. Consideration must be given to a means of reaeration to assure maintenance of an acceptable dissolved oxygen concentration in the stream following sulfonation.

103.44 Standby Equipment and Spare Parts

The same requirements apply as for chlorination systems. See Section 102.46.

103.45 Sulfonator Water Supply

The same requirements apply as for chlorination systems. See Section 102.47.

103.5 Housing Requirements

103.51 Feed and Storage Rooms

The requirements for housing SO_2 gas equipment should follow the same guidelines as used for chlorine gas. Refer to Section 102.5 for specific details.

When using solutions of the dechlorinating compounds, the solutions may be stored in a room that meets the safety and handling requirements set forth in Section 57. The mixing, storage, and solution delivery areas must be designed to contain or route solution spillage or leakage away from traffic areas to an appropriate containment unit.

103.52 Protective and Respiratory Gear

The respiratory air-pac protection equipment is the same as for chlorine. See Section 102.56. Leak repair kits of the type used for chlorine gas that are equipped with gasket material suitable for service with sulfur dioxide gas may be used. (Refer to The Compressed Gas Association Publication CGA G-3-1988, "Sulfur Dioxide.") For additional safety considerations, see Section 57.

103.6 Sampling and Control

103.61 Sampling

Facilities must be included for sampling the dechlorinated effluent for residual chlorine. Provisions must be made to monitor for dissolved oxygen concentration after sulfonation when required by the regulatory agency.

103.62 Testing and Control

Provision must be made for manual or automatic control of sulfonator feed rates based on chlorine residual measurement or flow.

104. ULTRAVIOLET RADIATION DISINFECTION

Design standards, operating data, and experience for this process are not well established. Therefore, expected performance of the ultraviolet radiation disinfection (UVRD) units must be based upon experience at similar full scale installations or thoroughly documented prototype testing with the particular wastewater. Critical parameters for UVRD units are dependent upon the manufacturers' design, lamp selection, tube materials, ballasts, configuration, control systems, and associated appurtenances. Proposals on this disinfection process will be reviewed on a case-by-case basis at the discretion of the reviewing authority under Section 53.2.

Open channel designs with modular UVRD units that can be removed from the flow are required. At least two banks in series must be provided in each channel for disinfection reliability and to ensure uninterrupted service during tube cleaning or other required maintenance. Operator safety and tube cleaning frequency must also be considered. The hydraulic properties of the system must be designed to simulate plug flow conditions under the full operating flow range. In addition, a positive means of water level control must be provided to achieve the necessary exposure time. Also refer to paragraphs 54.2 and 54.3.

This process should be limited to high quality effluent having at least 65% ultraviolet radiation transmittance at 254 nanometers wave length. As a general guide in systems sizing for an activated sludge effluent with the preceding characteristics at the design peak hourly flow, a UV radiation dosage of at least 30,000 $uWsec/cm^2$ may be used after adjustments for maximum tube fouling, lamp output reduction after 8760 hours of operation, and other energy absorption losses.

105. OZONE

Ozone systems for disinfection should be evaluated on a case-by-case basis. Design standards, operating data, and experience for this process are not well established. Therefore, design of these systems should be based upon experience at similar full scale installations or thoroughly documented prototype testing with the particular wastewater.

CHAPTER 110
SUPPLEMENTAL TREATMENT PROCESSES

111. PHOSPHORUS REMOVAL BY CHEMICAL TREATMENT

111.1 General

111.11 Method

Addition of lime or the salts of aluminum or iron may be used for the chemical removal of soluble phosphorus. The phosphorus reacts with the calcium, aluminum or iron ions to form insoluble compounds. These insoluble compounds may be flocculated with or without the addition of a coagulant aid such as a polyelectrolyte to facilitate separation by sedimentation.

111.12 Design Basis

111.121 Preliminary Testing

Laboratory, pilot or full scale studies of various chemical feed systems and treatment processes are recommended for existing plant facilities to determine the achievable performance level, cost-effective design criteria, and ranges of required chemical dosages.

The selection of a treatment process and chemical dosage for a new facility should be based on such factors as influent wastewater characteristics, effluent requirements, and anticipated treatment efficiency.

111.122 System Flexibility

Systems must be designed with sufficient flexibility to allow for several operational adjustments in chemical feed location, chemical feed rates, and for feeding alternate chemical compounds.

111.2 Process Requirements

111.21 Dosage

The design chemical dosage must include the amount needed to react with the phosphorus in the wastewater, the amount required to drive the chemical reaction to the desired state of completion, and the amount required due to inefficiencies in mixing or dispersion. Excessive chemical dosage should be avoided.

111.22 Chemical Selection

The choice of lime or the salts of aluminum or iron should be based on the wastewater characteristics and the economics of the total system. When lime is used, it may be necessary to neutralize the high pH prior to subsequent treatment in secondary biological systems or prior to discharge in those flow schemes where lime treatment is the final step in the treatment process.

111.23 Chemical Feed Points

Selection of chemical feed points must include consideration of the chemicals used in the process, necessary reaction times between chemical and polyelectrolyte additions, and the wastewater treatment processes and components utilized. Flexibility in feed locations must be provided to optimize chemical usage.

111.24 Flash Mixing

Each chemical must be mixed rapidly and uniformly with the flow stream. Where separate mixing basins are provided, they should be equipped with mechanical mixing devices. The detention period should be at least 30 seconds.

111.25 Flocculation

The particle size of the precipitate formed by chemical treatment may be very small. Consideration should be given in the process design to the addition of synthetic polyelectrolytes to aid settling. The flocculation equipment should be adjustable in order to obtain optimum floc growth, control deposition of solids, and prevent floc destruction.

111.26 Liquid - Solids Separation

The velocity through pipes or conduits from flocculation basins to settling basins should not exceed 1.5 feet per second (0.46 m/s) in order to minimize floc destruction. Entrance works to settling basins should also be designed to minimize floc shear.

Settling basins must be designed in accordance with Chapter 70. For design of the sludge handling system, special consideration should be given to the type and volume of sludge generated in the phosphorus removal process.

111.27 Filtration

Effluent filtration must be considered where effluent phosphorus concentrations of less than 1 mg/l must be achieved.

111.3 Feed Systems

111.31 Location

All liquid chemical mixing and feed installations should be installed on corrosion resistant pedestals and elevated above the highest liquid level anticipated during emergency conditions. The chemical feed equipment must be designed to meet the maximum dosage requirements for the design conditions. Lime feed equipment should be located so as to minimize the length of slurry conduits. All slurry conduits must be accessible for cleaning.

111.32 Liquid Chemical Feed System

Liquid chemical feed pumps should be of the positive displacement type with variable feed rate. Pumps must be selected to feed the full range of chemical quantities required for the phosphorus mass loading conditions anticipated with the largest unit out of service. Consideration should be given to systems including pumps and piping that will feed either ferric or aluminum compounds to provide flexibility. Refer to Section 111.51.

Screens and valves must be provided on the chemical feed pump suction lines.

An air break or anti-siphon device must be provided where the chemical solution stream discharges to the transport water stream to prevent an induction effect resulting in overfeed.

Consideration must be given to providing pacing equipment to optimize chemical feed rates.

111.33 Dry Chemical Feed System

Each dry chemical feeder must be equipped with a dissolver that is capable of providing a minimum 5-minute retention at the maximum feed rate.

Polyelectrolyte feed installations should be equipped with two solution vessels and transfer piping for solution make-up and daily operation.

Make-up tanks must be provided with an educator funnel or other appropriate arrangement for wetting the polymer during the preparation of the stock feed solution. Adequate mixing should be provided by a large-diameter, low-speed mixer.

111.4 Storage Facilities

111.41 Size

Storage facilities must be sufficient to insure that an adequate supply of the chemical is available at all times. Exact size required will depend on size of shipment, length of delivery time, and process requirements. Storage for a minimum of 10-days' supply should be provided.

111.42 Location and Containment

The liquid chemical storage tank and tank fill connections must be located within a containment structure having a capacity exceeding the total volume of all storage vessels. Valves on discharge lines must be located adjacent to the storage tank and within the containment structure. Refer to Section 57.2. Auxiliary facilities, including pumps and controls, within the containment area must be located above the highest anticipated liquid level. Containment areas must be sloped to a sump area and may not contain floor drains.

Bag storage should be located near the solution make-up point to avoid unnecessary transportation and housekeeping problems.

111.43 Accessories

Platforms, stairs, and railings should be provided as necessary, to afford convenient and safe access to all filling connections, storage tank entries, and measuring devices.

Storage tanks must have reasonable access provided to facilitate cleaning.

111.5 Other Requirements

111.51 Materials

All chemical feed equipment and storage facilities must be constructed of materials resistant to chemical attack by all chemicals normally used for phosphorus removal. Refer to Section 57.

111.52 Temperature, Humidity, and Dust Control

Precautions must be taken to prevent chemical storage tanks and feed lines from reaching temperatures likely to result in freezing or chemical crystallization at the concentration employed. A heated enclosure or insulation may be required. Consideration should be given to temperature, humidity, and dust control in all chemical feed room areas.

111.53 Cleaning

Consideration must be given to the accessibility of piping. Piping should be installed with plugged wyes, tees or crosses with removable plugs at changes in direction to facilitate cleaning.

111.54 Filling Drains and Draw-off

Above-bottom draw off from chemical storage or feed tanks must be provided to avoid withdrawal of settled solids into the feed system. A bottom drain must also be installed for periodic removal of accumulated settled solids. Provisions must be made in the fill lines to prevent back siphonage of chemical tank contents.

111.6 Safety and Hazardous Chemical Handling

The Chemical handling facilities must meet the appropriate safety and hazardous handling facilities requirements of Section 57.

111.7 Sludge Handling

Consideration must be given to the type and additional capacity of the sludge handling facilities needed when chemicals are added. Design of dewatering systems should be based, where possible, on an analysis of the characteristics of the sludge to be handled. Consideration should be given to the ease of operation, effect of recycle streams generated, production rate, moisture content, dewaterability, final disposal, and operating costs. Refer to Chapter 80.

112. HIGH RATE EFFLUENT FILTRATION

112.1 General

112.11 Applicability

Granular media filters may be used as an advanced treatment device for the removal of residual suspended solids from secondary effluents. Filters may be necessary where effluent concentrations of less than 20 mg/L of suspended solids and/or 1.0 mg/L of phosphorus must be achieved. A pre-treatment process such as chemical coagulation and sedimentation or other acceptable process should precede the filter units where effluent suspended solids requirements are less than 10 mg/L.

112.12 Design Considerations

Care should be given in designing pipes or conduits ahead of filter units, if applicable, to minimize shearing of floc particles. Consideration should be given in the plant design to providing flow-equalization facilities to moderate filter influent quality and quantity.

112.2 Filter Types

Filters may be of the gravity type or pressure type. Pressure filters must be provided with ready and convenient access to the media for inspection or cleaning. Where abnormal quantities of greases or similar solids, which result in filter plugging are expected, filters should be of the gravity type.

112.3 Filtration Rates

112.31 Allowable Rates

Filtration rates may not exceed 5 gpm/sq. ft. (3.40 l/m^2s) based on the design peak hourly flow rate applied to the filter units. The expected design maximum suspended solids loading to the filter should also be considered in determining the necessary filter area.

112.32 Number of Units

Total filter area must be provided in two or more units, and the filtration rate must be calculated based on the total available filter area with one unit out of service.

112.4 Backwash

112.41 Backwash Rate

The backwash rate must be adequate to fluidize and expand each media layer a minimum of 20 percent based on the media selected. The backwash system must be capable of providing variable backwash rates. Minimum and maximum backwash rates must be based on demonstrated satisfactory field experience under similar conditions. The design must provide for a backwash period of at least 10 minutes.

112.42 Backwash Pumps

Pumps for back-washing filter units must be sized and interconnected to provide the required backwash rate to any filter with the largest pump out of service. Filtered water from the clear well or chlorine tank must be used as the source of backwash water. Waste filter backwash must be adequately treated.

112.43 Backwash Surge Control

The rate of return of waste filter backwash water to treatment units must be controlled so that the rate does not exceed 15 percent of the design average daily flow rate to the treatment unit. The hydraulic and organic load from waste backwash water must be considered in the overall design of the treatment plant. Surge tanks must have a capacity of at least two backwash volumes, although additional capacity should be considered to allow for operational flexibility. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity must be provided with the largest unit out of service.

112.44 Backwash Water Storage

Total backwash water storage capacity provided in an effluent clearwell or other unit must equal or exceed the volume required for two complete backwash cycles.

112.5 Filter Media Selection

Selection of proper media type and size will depend on required effluent quality, the type of treatment provided prior to filtration, the filtration rate selected, and filter configuration. In dual or multi-media filters, media size selection must consider compatibility among media. Media must be selected and provided to meet specific conditions and requirements relative to the project under consideration. The selection and sizing of the media must be based on demonstrated satisfactory field experience under similar conditions. All media must have a uniformity coefficient of 1.7 or less. The uniformity coefficient, effective size, depth, and type of media must be set forth in the specifications.

112.6 Filter Appurtenances

The filters must be equipped with wash-water troughs, surface wash or air scouring equipment, means of measurement and positive control of the backwash rate, equipment for measuring filter head loss, positive means of shutting off flow to a filter being backwashed, and filter influent and effluent sampling points. If automatic controls are provided, there must be a manual override for operating equipment, including each individual valve essential to the filter operation. The underdrain system must be designed for uniform distribution of backwash water (and air, if provided) without danger of clogging from solids in the backwash water. If air is to be used for filter backwash, separate backwash blower(s) must be provided. Provision must be made to allow periodic chlorination of the filter influent or backwash water to control slime growths. When chemical disinfection is not provided at the plant, manual dosage of chlorine compounds is acceptable.

112.7 Access and Housing

Each filter unit must be designed and installed so that there is ready and convenient access to all components and the media surface for inspection and maintenance without taking other units out of service. Housing for filter units must be provided. The housing must be constructed of suitable corrosion-resistant materials. All controls must be enclosed and the structure housing filter, controls and equipment must be provided with adequate heat and ventilation equipment to minimize problems with excess humidity.

112.8 Proprietary Equipment

Where proprietary filtration equipment not conforming to the preceding requirements is proposed, data which supports the capability of the equipment to meet effluent requirements under design conditions must be provided. Such equipment will be reviewed on a case-by-case basis at the discretion of the regulatory agency. Refer to Section 53.2.

APPENDIX A
HANDLING AND TREATMENT OF SEPTAGE AT A WASTEWATER TREATMENT PLANT

A.1 GENERAL

One method of septage disposal is the discharge to a municipal or district wastewater treatment plant (WWTP). The handling and treatment of septage received at a WWTP is the subject of this appendix.

A.11 Septage Defined

Septage is a general term for the contents removed from septic tanks, portable vault toilets, privy vaults, holding tanks, grease traps, very small wastewater treatment plants, or semi-public facilities (i.e., schools, motels, mobile home parks, campgrounds, small commercial endeavors) receiving wastewater from domestic sources.

Non-domestic (industrial) wastes are not included in the definition and are not covered by this appendix.

A.12 Septage Characteristics

Compared to raw domestic wastewater from a conventional municipal sewer collection system, septage usually is quite high in organic, grease, and solids concentrations. Substantial quantities of phosphorus, ammonia nitrogen, bacterial growth inhibitors, and cleaning materials may be present in septage depending on the source. Tables No. 1 and No. 2 (Table 3-4 and 3-8 from the U.S. EPA handbook entitled "Septage Treatment and Disposal" 1984, EPA-625/6-84-009 reprinted herein) give a comparison of some of the common parameters for septage and municipal wastewater. Characteristics of septage may be expected to vary widely from load to load depending on the source (i.e., septic tank pumpage compared to grease traps or to recreational vehicles, or dump station holding tanks containing bacteria inhibitors).

A.2 TREATMENT OF SEPTAGE AT A WWTP

Septage is normally considered treatable at a WWTP with the exception of Facultative Lagoons. However, unless proper engineering planning and design is provided, septage may represent a shock loading or have other adverse impacts on plant processes and effluent quality which will be influenced by many factors including the following:

A.21 Capacity (MGD) (m^3/d) of the WWTP relative to the amount and rate of septage feed to the plant;

A.22 Unused WWTP capacity available (above current sewer collection system loadings) to treat septage loadings;

A.23 Sensitivity of the treatment plant process to daily fluctuations in loadings brought about by the addition of septage;

A.24 Sludge septage loadings of BOD, ammonia or phosphorus which may cause process upset, pass through to effluent, odor nuisance or other problems such as foaming aeration tank/aerated digester;

A.25 The point of introduction of the septage into the WWTP process. Feasible alternative points of feed to the WWTP units must be evaluated including feed to the sludge processing units provided the unit function will not be adversely affected;

A.26 The ability to control feed rates of septage to the WWTP during off peak loading periods;

A.27 The volume and concentrations of bacterial growth inhibitors in septage from some potable vault toilets and recreational dump station holding tanks; and

A.28 The permitted plant effluent regulatory limits for WWTP on each of the controlled parameters must be considered when evaluating these factors.

A.3 WWTP FACILITIES CONSIDERED FOR S EPTAGE TREATMENT

It is essential that an adequate engineering evaluation be made of the existing WWTP and the anticipated septage loading being considered prior to receiving septage at the WWTP. The regulatory agency must be contacted to obtain the appropriate approvals prior to the acceptance of septage. For proposed WWTP expansion and upgrading, the engineering report or facility plan (refer to Chapter 10) must include anticipated septage loading in addressing treatment plant sizing and process selection. The following items should be included as appropriate in the engineering evaluation and facility planning:

A.31 The uninterrupted and satisfactory treatment (within the plant regulatory limits) of wasteloads from the sewer system must not be adversely affected by the addition of septage to the plant;

A.32 In general, the smaller the WWTP design capacity relative to the septage loading proposed, the more subject the WWTP will be to upset and potential violation of permitted discharge effluent limits;

A.33 Allocation of organic plant capacity originally planned for future growth;

A.34 For plants to be expanded and upgraded, the engineering evaluation and facility planning should jointly consider the sensitivity of the WWTP process to receiving of septage, and the impact on the discharge parameter limits;

A.35 An evaluation of available WWTP operator staff and the staffing requirements necessary when septage is to be received. Staff should be present when septage is being received and unloaded. Added laboratory work associated with the receiving of septage for treatment should be included in the staffing evaluation;

A.36 The space for constructing septage receiving facilities that are to be off-line from the raw wastewater incoming from the sewer system. The location of the septage receiving facility and the septage hauler unloading area should consider other plant activity, and traffic flow; and

A.37 The impact of the septage handling and treatment on the WWTP sludge handling and processing units and ultimate sludge disposal procedures.

A.4 WWTP SEPTAGE RECEIVING FACILITY

The design of the septage receiving station at the WWTP should provide for the following elements:

A.41 Hard surface haul truck unloading ramp sloped to a drain to allow ready cleaning of any spillage and washing of the haul tank, connector hoses, and fittings. The ramp drainage must be tributary to treatment facilities and must exclude excessive stormwater;

A.42 A flexible hose fitted with easy connect coupling to provide for direct connection from the haul truck outlet to minimize spillage and help control odors;

A.43 Washdown water with ample pressure, hose, and spray nozzle for convenient cleaning of the septage receiving station and haul trucks. The use of chlorinated WWTP effluent may be considered for this purpose. If a potable water source is used, it must be protected in accordance with Section 56 of these Recommended Standards;

A.44 An adequate off-line septage receiving tank should be provided. Capability to collect a representative sample of any truck load of waste accepted for discharge at the WWTP must be provided. The receiving tank should be designed to provide complete draining and cleaning by means of a sloped bottom equipped with a drain sump. The design should give consideration to adequate mixing, for testing, uniformity of septage strength, and chemical addition, if necessary, for treatability and odor control. The WWTP must have authority to prevent and/or stop discharge that is likely to cause a WWTP discharge violation;

A.45 Screening, grit, and grease removal of the septage as appropriate to protect the WWTP treatment units;

A.46 Pumps provided for handling the septage should be of the non-clogging design and capable of passing 3-inch (76.2 mm) diameter solids;

A.47 Valving and piping for operational flexibility to allow the control of the flow rate and point of discharge of the septage to the WWTP;

A.48 Safety features to protect the operational personnel. Refer to Section 57; and

A.49 Laboratory and staffing capability to determine the septage strength and/or toxicity to the WWTP treatment processes. Provision for the WWTP operation reports to include the plant load attributed to septage.

APPENDIX A
TABLE NO. 1*

PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEPTAGE,
AS FOUND IN THE LITERATURE, WITH SUGGESTED DESIGN VALUES [a, b]

	United States (5) (9-19)				Europe/Canada (4) (20)					
Parameter	Average	Minimum	Maximum	Variance	Average	Minimum	Maximum	Variance	EPA Mean	Suggested Design
TS	34,106	1,132	130,475	115	33,800	200	123,860	619	38,800	40,000
TVS	23,100	353	71,402	202	31,600	160	67,570	422	25,260	25,000
TSS	12,862	310	93,370	301	45,000	5,000	70,920	14	13,000	15,000
VSS	9,027	95	51,500	542	29,900	4,000	52,370	13	8,720	10,000
BOD_5	6,480	440	78,600	179	8,343	700	25,000	36	5,000	7,000
COD	31,900	1,500	703,000	469	28,975	1,300	114,870	88	42,850	15,000
TKN	588	66	1,060	16	1,067	150	2,570	17	677	700
NH_3-N	97	3	116	39	---	---	---	---	157	150
Total P	210	20	760	38	155	20	636	32	253	250
Alkalinity	970	522	4,190	8	---	---	---	---	---	1,000
Grease	5,600	208	23,368	112	---	---	---	---	9,090	8,000
pH	---	1.5	12.6	8	---	5.2	9.0		6.9	6.0
LAS	---	110	200	2	---	---	---	---	157	150

a Values expressed as mg/L, except for pH.

b The data presented in this table were compiled from many sources. The inconsistency of individual data sets results in some skewing of the data and discrepancies when individual parameters are compared. This is taken into account in offering suggested design values.

- Table No. 1 including footnotes is taken from the US EPA Handbook entitled, "Septage Treatment and Disposal," 1984, EPA-625/6-84-009 and is designated in that documer "Table 3-4."

APPENDIX A TABLE NO. 2*

COMPARISON OF SEPTAGE AND MUNICIPAL WASTEWATER [a]

Parameter	Septage [b]	Wastewater [c]	Ratio of Septage to Wastewater
TS	40,000	720	55:1
TVS	25,000	365	68:1
TSS	15,000	220	68:1
VSS	10,000	165	61:1
BOD_5	7,000	220	32:1
COD	15,000	500	30:1
TKN	700	40	17:1
NH_3-N	150	25	6:1
Total P	250	8	31:1
Alkalinity	1,000	100	10:1
Grease	8,000	100	80:1
pH	6.0	---	---
LAS	150	---	---

a. Values expressed as mg/L, except for pH.
b. Based on suggested design values in Table No. 1 (US EPA Table 3-4).
c. From Metcalf and Eddy, 2nd Edition, "medium strength sewage."
* Table No. 2 including footnotes is taken from the US EPA Handbook entitled "Septage Treatment and Disposal," 1984, EPA-625/6-84-009 and is designated in that document as "Table 3-8."

APPENDIX B
STANDARDS FOR THE SPRAY IRRIGATION OF WASTEWATER

B.1 GENERAL

These standards must be used for the design and review of projects involving spray irrigation of sewage effluent from a domestic wastewater treatment facility. It was assumed in the development of these standards that the industrial component of the influent wastes is relatively small with the discharge of toxic substances regulated by an effective pretreatment program.

B.2 DEFINITIONS

B.21 Food Crops

Food crops means any crops intended for human consumption.

B.22 Spray Irrigation

Spray irrigation means application of reclaimed water to crops by spraying it from orifices in piping.

B.23 Oxidized Wastewater

Oxidized wastewater means wastewater in which the organic matter has been stabilized, is nonputrescible, and contains dissolved oxygen. This level of treatment is comparable to that from facilities producing secondary effluent. See Tables 93-1 and 93-2.

B.24 Coagulated Wastewater

Coagulated wastewater means oxidized wastewater in which colloidal and finely divided suspended matter have been destabilized and agglomerated by the addition of suitable floc-forming chemicals or by an equally effective method.

B.25 Filtered Wastewater

Filtered wastewater means an oxidized, clarified wastewater which has been passed through natural undisturbed soils or filter media, such as sand or diatomaceous earth, so that the turbidity as determined by an approved laboratory method does not exceed an average operating turbidity of two N.T.U. and does not exceed five N.T.U. more than five percent of the time during any 24-hour period.

B.26 Disinfected Wastewater

Disinfected wastewater means wastewater in which the pathogenic organisms have been destroyed by chemical, physical or biological means.

B.3 DESIGN REPORT

In addition to the requirements of Chapter 10, the design report must include:

B.31 Justification of the hydraulic, nitrogen and trace element loading rates.

B.311 The methods published in Chapter 4 of the "Process Design Manual for Land Treatment of Municipal Wastewaters" (EPA 625/1-81-013) or succeeding documents, published by the U.S. Environmental Protection Agency, must be employed in determining hydraulic and nitrogen loading rates.

B.312 Hydraulic loading must be based on the wettest year in ten.

B.32 Further investigation will be required when the application of any trace element exceeds the amount specified in Table 19 of EPA Guidelines for Water Reuse EPA/625/R-92004 September 1992.

B.33 Representative data on the chemical quality of the treated wastewater must be submitted including the concentration of calcium, magnesium, sodium, bicarbonate, chloride, sulfate, nitrate, boron, hardness, TDS, iron, and heavy metals.

B.34 Groundwater, soil, and agronomic information specific to the irrigation site.

B.4 SPRAY IRRIGATION OF FOOD CROPS

B.41 Reclaimed water used for the spray irrigation of food crops must be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater. The wastewater effluent quality should have approximately 10 mg/L or less of BOD and TSS. The wastewater will be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30-day period. The median value must be determined from the bacteriological results of the last seven days for which analyses have been completed.

B.42 A relaxation of the treatment requirements for reclaimed water used for irrigation of food crops may be considered by the department on an individual case basis where the reclaimed water is to be used to irrigate a food crop which must undergo extensive commercial, physical or chemical processing sufficient to destroy pathogenic agents before it is suitable for human consumption.

B.5 SPRAY IRRIGATION OF FODDER, FIBER AND SEED CROPS

B.51 Reclaimed water used for surface or spray irrigation of fodder, fiber and seed crops must be an adequately oxidized wastewater.

B.52 Disinfection will generally not be required for fodder, fiber and seed crops. Where effluent is not disinfected, fencing must be provided and, in general, a 200-foot buffer zone must be maintained between the fencing and the irrigated land. A distance of 200 feet must also be maintained between the irrigated land and any dwelling, including residential property. Where the 200-foot buffer zone is not owned by the party irrigating, an easement must be obtained prohibiting construction of any dwelling within the buffer zone. In all cases the department may require a buffer zone wider than 200 feet.

The buffer zone may be reduced with improved levels of treatment and disinfection or in cases of minimal potential for public contact.

B.53 Reclaimed water used for irrigation of pasture to which milking cows or goats have access must be at all times an adequately disinfected, oxidized wastewater. Wastewater is considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 23 per 100 milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed.

B.6 LANDSCAPE IRRIGATION

B.61 Reclaimed water used for the irrigation of golf courses, cemeteries, freeway landscapes, and landscapes in other areas where the public has similar access or exposure must be at all times an adequately disinfected, oxidized wastewater. Wastewater is considered adequately disinfected if the median number of fecal coliform organisms in the effluent does not exceed 200 per 100 milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed, and the number of fecal coliform organisms does not exceed 400 per 100 milliliters in any two consecutive samples. Public access to the spray irrigation site must be restricted during the period of application. Buffer zones will be determined on a case-by-case basis if less than 200 feet. If low-trajectory nozzles are used, the buffer zone can be reduced to 50 feet.

B.62 Reclaimed water used for the irrigation of parks, playgrounds, school yards, unrestricted golf courses and other areas where the public has similar access or exposure must be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater or a wastewater treated by a sequence of unit processes that will assure an equivalent degree of treatment and reliability. Wastewater is considered adequately disinfected if the median number of coliform organisms in the effluent does not exceed 2.2 per 100 milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed, and the number of coliform organisms does not exceed 23 per 100 milliliters in any sample.

B.7 DISTANCE FROM SURFACE WATERS AND WELLS

B.71 In all cases, the spray irrigation site must be at least 100 feet from any water supply well. The required distance from surface water will be determined on a case-by-case basis based on the quality of effluent and the level of disinfection.

B.8 OPERATION AND MAINTENANCE MANUAL

An Operation and Maintenance Manual must be submitted, including operating procedures for:

B.81 Cold weather operation.

B.82 Responsibility of operation. Where spray irrigation is part of the treatment process, the wastewater system operator must make the final decision on when spray irrigation may proceed. Safe operating practices must be described and encouraged.

B.83 Maximum allowable wind velocity during operation. In general, the maximum is 25 mph, however, the reviewing authority may require a lower maximum limit.

B.84 Drying/wetting ratio. The drying/wetting ratio must generally be no less than 3 to 1. However, the reviewing authority may require a larger ratio.

B.85 Monitoring of groundwater. Monitoring data may be required by the reviewing authority on a case-by-case basis. Consideration will be given to groundwater characteristics, past practices, depth to groundwater, cropping practices, etc. when determining the need for monitoring. Procedures for collection and analyses of samples must be provided.

B.86 Effluent must be monitored on a regular basis to show the biochemical and bacteriological quality of the applied wastewater. The reviewing authority will determine the monitoring frequency on a case-by-case basis. The frequency, parameters and procedures for monitoring must be included in the Operation and Maintenance Manual.

B.87 The O&M manual must include instructions for development of an operating plan for the irrigation system including cropping practices, nutrient loading, water balances, etc. giving consideration to the agronomic practices applicable to a specific site.

B.9 CONTROL OF IRRIGATED LAND

When the spray field is not owned by the party irrigating, a 20-year lease or similar assurance must be negotiated in order to ensure control of irrigated land. A copy of the signed lease must be submitted to the reviewing authority.

B.10 ENCOURAGED PRACTICES

The following practices are encouraged:

B.101 Cultivation of trees and shrubs to serve as a screen around the spray field.

B.102 The use of low trajectory nozzles on spray irrigation equipment as a measure to reduce airborne aerosols.

APPENDIX C
DESIGN STANDARDS FOR ALTERNATIVE SEWER SYSTEMS

C.1 GENERAL

These standards must be used for design of alternate sewer systems. Variances will be allowed where adequate justification is provided by the design engineer. These standards may be modified as the technology evolves.

C.2 SMALL DIAMETER GRAVITY SEWER DESIGN

C.21 Small diameter gravity sewers may be used for septic tank effluent only.

C.22 Hydraulic Considerations

C.221 Design flow must be based upon water use records where available. If water use records are not available, 70 gpcd per residential connection must be used with additional flow allowances for infiltration and an appropriate peaking factor (see section 11.24).

C.222 Hydraulic calculations must be based on the Manning's formula with a roughness coefficient of n = 0.013.

C.223 Hydraulic design must be based upon an approximately 1/2 to 3/4 full pipe at 20-year peak design flow.

C.224 Minimum design velocity of 1.0 fps in controlling sections should be used considering existing peak flow conditions.

C.23 All mains must be 4-inch diameter pipe or larger.

C.24 To minimize potential sources of infiltration, 20 foot minimum pipe lengths and in-line service fittings should be used.

C.25 Detection wires for locating buried pipe should be considered.

C.26 Turbulence should be minimized wherever possible.

C.27 Performance tests specified in Chapter 30 just be utilized for determining water-tightness, deflection and alignment of installed pipes.

C.28 Service lines and main lines must be designed and constructed to prevent freezing of the wastewater within the lines.

C.3 MANHOLES/CLEANOUTS

C.31 The limited use of manholes is encouraged to minimize infiltration, reduce odor potential, limit introduction of extraneous materials and reduce cost. Manholes are to be located at major junctions of three or more pipes and limited to strategic locations for cleaning purposes. Watertight manhole covers are recommended for odor control and to limit inflow.

C.32 Manholes located in groundwater must be waterproofed and should be of the type, which has the base riser section cast with an integral floor.

C.33 Cleanouts should be used in place of manholes at changes in grade, alignment, and at intersections of pipe. Spacing of cleanouts depends upon cleaning capabilities. A maximum of 600 feet for mechanically cleaned and jet-cleaned systems and a maximum of 1000 feet for systems cleaned by pigging.

C.34 Cleanouts located in traffic areas must be designed to withstand normal traffic loads without damage.

DESIGN STANDARDS FOR PUMP STATIONS FOR ALTERNATIVE COLLECTION SYSTEMS

C.4 GENERAL

In addition to the requirements of Sections 41 through 48, the following standards apply to pump stations that pump septic tank effluent:

C.41 Pumps other than those capable of passing spheres of at least 3 inches in diameter are acceptable. Screens should be considered where this type of pump is used.

C.42 The inlet pipe must be extended below the low water elevation in the wet well in order to reduce turbulence and odors.

C.43 The lift station wet well cover must be watertight for odor control.

C.44 A vent must be provided with odor control. The vent can be connected to a buried gravel bed or to a charcoal filter.

C.45 Materials in the wet well must be protected from corrosion. Stainless steel, plastic, or bronze materials are recommended.

C.46 The force main sizing must be based upon hydraulic requirements using a minimum design velocity of 1.0 ft/sec based on a Manning's roughness coefficient of n = 0.013. The minimum pipe diameter for force mains is 1.5 inches.

C.47 The force main must be designed and constructed to prevent freezing.

C.5 SEPTIC TANK/EFFLUENT PUMPS

C.51 Typically one septic tank and one effluent pump per household will be provided. Multiple units may be considered where serving multiple family dwellings or trailer courts. Duplex pumps, each capable of handling maximum flow, may be required in these situations.

C.52 Pumping units will be activated by appropriate level control switches. High and low level alarms will be required with audio-visual alarms recommended. Low level pump deactivation controls must be provided. A control panel with appropriate circuit protection and electrical safety devices must be used. The alarm circuit should be separately wired from the pump circuit. All applicable electrical codes must be satisfied. The power cables to the pump must be designed for extra-hard usage. Electrical components must be designed to facilitate maintenance of the pumping unit. Wiring must be exterior to the residence for maintenance purposes.

C.53 Screens limiting solids carryover into the pump must be provided. Pipe fittings used should be commonly available. Appropriate isolation, check, and air release valves must be used with ease of maintenance in mind. All components must be protected from freezing.

C.54 All septic tanks must be vented.

C.6 SEPTIC TANKS

C.61 Septic tanks must conform to the requirements of DEQ Circular DEQ 4, Chapter 50, Septic Tanks.

C.62 In addition to the requirements of Circular DEQ 4, the following guidelines must be considered:

C.621 Two compartment tanks or screening of effluent should be evaluated to minimize solids carryover.

C.622 "Tee" inlet and outlet baffles with removable caps for control of venting are recommended. Caps should have 1/8-inch hole drilled in them.

C.623 Watertight precast concrete, fiberglass or polyethylene tanks must be utilized.

C.624 All septic tanks must be individually tested for watertightness.

C.625 Concrete tanks must be constructed with type II or V cement and coated with a heavy cement-base waterproof coating on both the inside and outside surfaces. Tanks must be designed to carry all expected loads utilizing sufficient concrete thickness and reinforcing steel.

C.626 Walls and bottom of reinforced-concrete tanks must be poured monolithically. Cold joints located below the waterline are not allowed.

C.627 Tanks must be installed at level grade, placed on undisturbed earth free of large stones or suitable structural fill.

C.628 Screens around effluent tee should be considered to minimize solids carryover.

C.7 GRINDER PUMPS

Small grinder pump stations which are approved by UL or other independent laboratory are exempt from meeting the requirements of chapter 40. However, the dry well must be completely separated and sealed from the wet well.

C.8 AERATORS

C.81 Aerators of either the mechanical or nonmechanical type must be provided so that all septic tank effluent is aerated prior to entering a conventional sewer or treatment facility. A reaction time of at least two minutes should be provided between the aerator and the discharge point in order to maximize the contact between anaerobic sewer gases and the newly introduced oxygen.

C.82 Consideration should be given to isolating the septic tank effluent gases prior to discharging into a conventional gravity sewer.

APPENDIX D
STANDARDS FOR RAPID INFILTRATION BASINS

D.1 GENERAL

These standards should be used for the design and review of projects involving rapid infiltration (RI) or infiltration/percolation (I/P) cells for the land application of effluent from a domestic wastewater treatment facility. It was assumed in the development of these standards that the industrial component of the influent wastes is relatively small, with the discharge of toxic substances regulated by an effective pretreatment program. If significant industrial users discharge to the system, additional requirements may be imposed.

Systems using rapid infiltration basins may be required to obtain a groundwater discharge permit from the regulatory agency. In addition, if the groundwater discharge is hydrologically connected to a surface water, a Montana Pollutant Discharge Elimination System permit may be required.

D.2 PREAPPLICATION TREATMENT

At a minimum, treatment comparable to secondary treatment must precede all rapid infiltration applications. For RI applications following lagoons, preapplication treatment must be in accordance with to Section 93, Tables 93-1 and 93-2.

D.3 DESIGN REPORT

A comprehensive preliminary design report must be submitted to the reviewing authority prior to the final design phase. The design report must include the following:

1. Field observations of exposed soil profiles (on and near the site) to include road cuts, borrow pits, and plowed fields.

2. Field observation of groundwater indicators: wet spots, seepage areas, vegetation changes, ponds and streams, and general drainage characteristics.

3. Backhoe test pit results, to 10 feet, in the major soil types on the site. Special consideration should be given to the evaluation of the characteristics of the soil near the surface of the proposed basin and the elevation of the groundwater on the site.

4. Water levels in adjacent or on-site wells and nearby surface waters should be used to prepare a preliminary water table map. Include flow direction, depth, and discharge areas for groundwater and the re-charge characteristics for the site.

5. Included in the design report should be information describing the quality of the groundwater, current nitrate levels its uses and classification.

6. Calculations supporting the proposed hydraulic loading to the cell, including analyses of groundwater mounding potential, nitrate loading to groundwater, percolation rates and cycle times.

7. Winter time storage requirements if necessary.

8. Chemical characteristics and compatibility of the soil and wastewater, predicted organic and nutrient removal rates.

9. A preliminary layout of the proposed basins showing dimensions of the cells, proximity to wells, seeps, springs, lakes and streams.

10. A preliminary cost breakdown of the proposed basins and storage cells if required.

D.4 SITE SELECTION

D.41 The site location must be selected so that the basins are protected from flooding and must not be located in the 100-year flood plain.

D.42 If the groundwater beneath the proposed RI site is hydrologically connected to surface water, then the discharge will be considered the same as a surface water discharge and surface water standards will apply.

D.43 The operation of an RI system on the proposed site may not affect any existing or anticipated uses of groundwater or surface water.

D.5 SITE INVESTIGATION

D.51 Final field testing must be conducted on the actual site and at the actual depth in the soil profile intended for the RI system. Extrapolation of data from nearby sites is not an acceptable basis for design.

D.52 Soils Investigation

D.521 Sufficient information on soil gradation, plasticity, texture, moisture, and structural characteristics should be obtained to thoroughly evaluate the permeability and drainage characteristics of the site.

D.522 Test pits and borings are required on all sites proposed in the final design. The number of pits and borings depends on the uniformity of the soils in the area. However, enough test pits must be dug and enough borings drilled to adequately characterize the soil profile and soil characteristics of the entire site. Generally, a grid-type approach must be used to establish the test pit locations.

D.523 Infiltration and permeability tests must be conducted in-situ at the proposed site whenever possible. Laboratory permeability tests may be allowed in certain limited situations. Sufficient wetting and drying cycles should be used so that conditions similar to the proposed conditions of the RI cell can be evaluated.

D.524 A phosphorous break-through analysis must be performed for each major soil type within the site. The analysis must include a phosphorous adsorption test.

D.6 LOADING RATES

D.61 The hydraulic loading rate must be based directly upon the field and laboratory test results for infiltration, permeability, and hydraulic conductivity.

D.62 Hydraulic conductivity must be based on the layer of soil that is most restrictive of water flow. If there is not an obvious restricting layer in the soil profile, then the effective hydraulic conductivity of the profile is the mean of the values observed in the tests.

D.63 A percentage of the effective hydraulic conductivity must be used as the design loading rate. This percentage must be based on the following table:

Test Procedure	Adjustment Factor for Annual Loading
Basin Flooding Test	10-15% of "effective" rate observed
Air entry permeameter & cylinder infiltrometers	2 - 4% of "effective" rate observed
Laboratory permeability measurements	4 - 10% of "effective" rate observed or of restricting soil layer.

D.64 Hydraulic loading rate must be given in gal/(yr ft^2). The annual loading rate must be reduced to account for periods when RI cells cannot be used, such as when the ground is frozen or during maintenance periods.

D.7 MAXIMUM GROUNDWATER ELEVATION

There must be, at all times, an unsaturated zone between the bottom of the RI basin and the maximum groundwater surface as determined by a groundwater mound analysis. This analysis must be performed by a qualified hydrogeologist.

D.8 UNDERDRAINS

Underdrains may be required to control groundwater mounding and to prevent surfacing of infiltrated wastewater. The discharge from underdrains which collect treated effluent from RI systems will be considered the same as a surface water discharge, and surface water standards will apply.

D.9 WET/DRY RATIOS

Wet/dry ratios appropriate for the treatment goals must be used. Special consideration should be given in the design phase to allow enough drying time between applications to prevent soil clogging.

D.10 APPLICATION RATES

Application rates must be based on the annual hydraulic loading rate, time available for application, wet/dry ratios, and nondegradation regulations for groundwater and surface water.

D.11 NUMBER OF CELLS

In determining the number of RI cells to use, consideration must be given to drying time for the cells and for the maintenance of cells without disrupting the continual operation of the treatment works.

D.12 INLET STRUCTURES

Inlet structures must be provided for all basins to prevent erosion of the basin or adjacent dike. At a minimum, concrete splash pads are required.

D.13 FLOW DISTRIBUTION

D.131 Influent wastewater must be distributed uniformly over the entire basin area.

D.132 Interpond or flow control structures must be provided as necessary to adequately direct and control wastewater flow to any individual RI basin.

D.14 STORAGE REQUIREMENTS

Where the RI basins will not perform satisfactorily during the winter months, provisions for storing the wastewater during that period are required.

D.15 DIKES

D.151 Minimum dike slope is 3:1

D.152 Dike height must be sufficient to prevent washout from wind-induced waves. However, dikes may not be excessively high so that erosion of the soil fines from runoff is kept to a minimum.

D.16 OVERFLOW PROTECTION

Overflow protection must be provided for all RI basins to prevent washout of the dikes. Overflow pipes must be inter-cellular and may not discharge outside of the basin area.

D.17 CONSTRUCTION PRACTICES

D.171 RI basins may not be constructed on backfilled materials without specific approval by the reviewing authority.

D.172 The final surface of the RI basin must be uniformly graded to allow even distribution of the wastewater and utilization of the entire soil profile for treatment.

D.173 Every effort must be made to avoid compaction of the treatment area within the basins. The basin bottom surface must be scarified prior to facility start-up.

D.18 GROUNDWATER MONITORING

A minimum of three groundwater monitoring wells must be installed near the RI basins. One of the wells must be placed upgradient (with respect to groundwater flow) and two wells must be placed downgradient from the RI site.

D.19 ACCESS

The RI basin site must be enclosed with a fence and posted with signs designed to discourage the entrance of unauthorized persons and animals.

APPENDIX E
CAPACITY DEVELOPMENT FOR WASTEWATER SYSTEMS

E.1 GENERAL

In addition to the information required in the circular, information on management, operation, maintenance, and financing of the system must be submitted. The purpose of this information is to allow evaluation of a new system for proper system management, operation and maintenance (O&M), and financial planning that provides long-term stability of the new system.

Capacity terms are defined as follows:

Managerial capability (capacity) means the management structure of the system, including but not limited to ownership accountability, staffing, and organization.

Technical capability (capacity) means the physical infrastructure of the system, including but not limited to infrastructure adequacy and technical knowledge based on information provided by the borrower and its own inquiry of system operators.

Financial capability (capacity) means the financial resources of the system, including, but not limited to, the revenue sufficiency, credit worthiness, and fiscal controls.

The DEQ is granted the authority in Title 75, Chapter 6, Part 1, MCA, to ensure financial viability of proposed public water supply and public sewage systems as necessary to ensure the capability of the system to meet the requirements of 75-6-103, MCA.

E.2 MANAGERIAL CAPACITY

Provide the following information:

1. Name of the owner(s), address, telephone number. If ownership is to change in the near future, such as in a subdivision where the developer will eventually relinquish ownership to another responsible entity, provide a projected time line for change of ownership.

2. Administrative and management organizational charts. Define the functions and responsibilities of the organization and each administrative/managerial position. For example, if the organization has a secretary, provide a brief description of the secretary's responsibilities.

3. Plans for staffing the system with a certified operator and back-up operator. Provide the name of the operator if an operator has been selected. An operator should be available to operate the system even if the system has not yet become public. If the system is operated under contracted services, provide a copy of the contract.

4. A system or plan for maintaining records, plans and specifications for construction, as-built drawings, O&M manuals, collection system histories/maps, and compliance information. Preferably, an office space should be dedicated for storing all information so that it is readily accessible by the operator, manager(s), and owner(s) of the system.

5. Copies of by-laws or similar documents that provide the following information:

   A. Define the purpose of the responsible entity.
   B. Describe the procedures for compliance with the requirements of the Secretary of State's Office for creating and maintaining a non-profit association.
   C. Membership/membership rights (all lot owners should automatically become members unless they are not in good standing, which should be defined).
   D. Format and schedule for meetings and requirements for quorums.
   E. The powers and duties of the board of directors.
   F. The procedures for amendment of the by-laws.
   G. Authority to assess and collect fees for O&M, monitoring, personnel, capital improvements and equipment replacement.
   H. Establish the service area of the responsible entity.

   Also, provide policies on how delinquent accounts, system violations, fee changes, and customer complaints will be addressed. The responsible entity must file its by-laws with the Secretary of State.

6. If the responsible entity becomes insolvent, how will perpetuation of the system be maintained? Has a second party been considered for future ownership in the event that the responsible entity becomes insolvent?

   The managerial plan must provide for:

   A. Efficient operation of the system.
   B. Owner(s), manager(s), and operator to be accountable for the system.
   C. Owner(s), manager(s) and operator to be apprised of regulatory requirements.
   D. Dissemination of information to all customers and the regulatory agencies.

E.3 TECHNICAL, OPERATIONAL, AND MAINTENANCE CAPACITY

Provide the following information in the form of an O&M manual that will be available to the operator, owner(s), and manager(s):

1. An explanation of startup and normal operation procedures. The explanation of startup should address operation of the system throughout system buildout if applicable (i.e., a subdivision will experience varying demands as the subdivision develops and builds out).

2. Will any equipment be leased or rented? Are easement or lease agreements necessary for any portion of the system? If applicable, please provide pertinent information (i.e., copy of easement or lease agreement). Are changes in local zoning necessary to protect the proposed source(s)?

3. Records and reporting system, if applicable.

4. Sampling and analyses program to demonstrate compliance with any applicable discharge permit.

5. Staffing and training requirements to operate the system in compliance with any applicable discharge permit.

6. Documentation of a safety program.

7. Documentation of an emergency plan and operating procedures (e.g., in the case of chemical spill or loss of power).

8. Manufacturers' manuals for all equipment and contact names for service. A routine maintenance program and maintenance schedules must also be included. Forms for recording routine maintenance checks per manufacturers' guidelines should be provided, including recording the frequency of maintenance and anticipated replacement dates for major equipment.

Items 1 through 5 must be submitted in the form of an O&M manual.

A letter from the applicant must be provided prior to the system being used indicating that the system (or portion of the system that has been completed) was constructed in conformance with the approved plans and specifications. As-built for the system (or portion of the system that has been completed) must be provided within 90 days after the system has become operational. The as-built must include an O&M manual addressing items 1 through 9 and containing manufacturers' manuals and other pertinent information to complete the O&M manual.

The manual must demonstrate that the system will be operated in a manner to:

A. Maintain compliance with the Montana Water Quality Act and any discharge permit
B. Allow effective operation of the system in accordance with the approved plans and specifications.
C. Remain consistent with operating conditions presented in the engineer's report.

E.4 FINANCIAL CAPACITY

The following financial information must be submitted prior to receiving approval of the system:

1. The financial information in Table E-1 must be completed for a 5-year period.

2. O&M rates and capital improvement/replacement rates must be developed based on information in Table E-1. A capital improvement/replacement plan must be developed for a 20-year period and the rate set accordingly. How will a reserve fund be established and maintained to address future replacement of equipment based on anticipated replacement dates for equipment?

3. If customers are metered, demonstrate that rates account for metering (cost of meters, cost of operator to read/maintain meters), and demonstrate how rates correspond to meter readings.

4. Connection/system development fee and basis for fee, if applicable.

5. Does the owner(s) or responsible entity have access to financial capital? If a large sum of money is necessary for replacement, improvement, or expansion, can the owner(s) or responsible entity obtain a loan or grant?

6. How will the budget be controlled? Will audits be routinely performed?

7. If the system is privately owned, has the Department of Public Service Regulation been contacted?

8. Provide a financial plan that demonstrates that all improvements will be constructed in conformance with the proposed plans and specifications. If bonding has been provided with a regulating entity (such as the county) for improvements, provide information on the bonded improvements.

The financial plan must demonstrate:

A. Revenues exceed expenses.
B. Adequate funds will be maintained for replacement of equipment.
C. A reserve account will be maintained.
D. The budget will be controlled, preferably by audits every 3 to 5 years.
E. The 5-year cash flow presented in Table E-1 is sufficient to properly operate the system.
F. That all proposed improvements will be constructed.

TABLE E-1 -- SYSTEM BUDGET

Applicant:___________________________________ Completed by:_________________ Date:_______________

5 Year Projections	Year 1 Projected	Year 2 Projected	Year 3 Projected	Year 4 Projected	Year 5 Projected
Enter Year:					
1. Beginning Cash on Hand					
2. Cash Receipts:					
a. Total Revenues					
b. Connection Fees					
c. Interest and Dividend Income					
d. Other Income					
e. Total Cash Revenues (2a thru 2d)					
f. Transfers in/Additional Rev Needed					
g. Loans, Grants or other Cash Injection					
h. other - please specify					
3. Total Cash Receipts (2e thru 2h)					
4. Total Cash Available (1 + 3)					
5. Operating Expenses					
a. Salaries and wages					
b. Employee Pensions and Benefits					
c. Purchased Water					
d. Purchased Power					
e. Fuel for Power Production					
f. Chemicals					
g. Materials and Supplies					
h. Contractual Services - Engineering					
i. Contractual Services - Other					
j. Rental of Equipment/Real Property					
k. Transportation Expenses					
l. Laboratory					
m. Insurance					
n. Regulatory Commission Expenses					
o. Advertising					
p. Miscellaneous					
q. Total Cash O & M Expenses (5a + 5p)					
r. Replacement Expenditures					
s. Total O M & R Expenditures (5q + 5r)					
t. Loan Principal/Capital Lease Payments					
u. Loan Interest Payments					
v. Transfers Out					
w. Capital Purchases (specify)					
x. Other					
6. Total Cash Paid out (5s thru 5x)					
7. Ending Cash Position (4 - 6)					
8. Number of Customer Accounts					
9. Average Annual User charge Account users:(2a/8)					
10. End of Year Reserves					
a. Debt Service Reserve					
b. Bond Retirement Reserve					
c. Capital Improvement Reserve					
d. Replacement Reserve					
e. Total Reserves (10a thru 10 d)					
11. End of Year Operating Cash (7 - 10e)					